VL/H CALIB. LAB.

INSTRUCTION MANUAL

DIGITAL STORAGE OSCILLOSCOPE

MODEL DSS5020

Kikusui
INTERNATIONAL CORP.

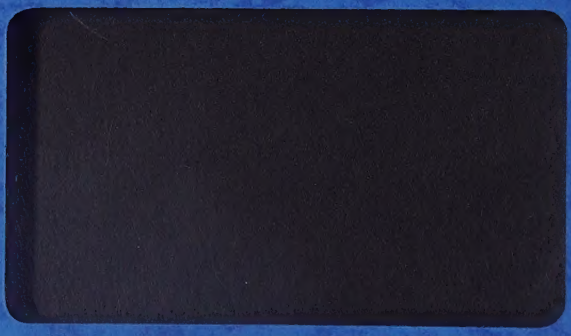

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TABLE OF CONTENTS

		PAGE
1.	GENERAL	1
2.	SPECIFICATIONS	3
3.	GENERAL PRECAUTIONS	12
4.	DESCRIPTION OF PANELS	15
	4.1 Description of Front Panel	15
	4.2 Description of Rear Panel	28
5.	BASIC OPERATION METHOD	30
	5.1 AC Line Voltage Setting	30
	5.2 To Display a Trace on the CRT	30
	5.3 To Align the Trace With the Graticule Line	32
	5.4 Calibration of Probe	33
6.	MEASUREMENTS OF WAVEFORM	34
	6.1 Measurement in Non-storage Mode	34
	(1) Single-channel Operation	34
	(2) Dual-channel Operation	35
	(3) To Add Two Waveforms	38
	(4) To Use as an X-Y Scope	39
	(5) Triggering	42
	(6) Single-sweep Operation	51
	(7) Sweep Magnification	54
	6.2 Measurement in Storage Mode	55
	(1) Waveform Measurement in Storage Mode	56
	(2) To Save Waveform	60
	(3) To Magnify the Saved Waveform	60
	(4) To Compare Waveforms	61
	(5) To Save Waveform in Single-sweep Mode	62
	(6) To View Waveform Existed Before Triggering	62

PAGE

7. OPERATING PRINCIPLE 66

7.1 Basic Principle of Digital Storage Oscilloscope 66

7.2 Circuit Structure 67

8. MAINTENANCE AND STORING 71

1. GENERAL

The DSS5020 is a portable dual-channel digital storage oscilloscope. It is incorporated with an 8-bit CPU, renders a maximum sampling rate of 1 MHz and an effective storage frequency of 400 kHz, has a memory capacity of 1024 words per channel, and is able to be used as a dual-channel digital storage oscilloscope with interpolation of data saved in the memory, or is able to be used as a real-time oscilloscope of 20 MHz. The most outstanding features of the DSS5020 are as follows:

(1) Effective storage frequency range of DC - 400 kHz

Interpolation can be done for both sinusoidal waves and pulse waves and consequently even one-shot sinusoidal waves can be accurately displayed.

(2) Waveform magnification

The saved waveforms can be displayed being magnified by up to 100 times, from one of three selectable points.

(3) Useful functions

The various useful functions such as for comparison of waveforms and measurement of slow speed signals, one-shot events, and signals before the triggered point are incorporated.

(4) A trigger level lock function which makes triggering adjustment procedure unnecessary

A new trigger level lock circuit is incorporated. This circuit eliminates the requirement of troublesome triggering adjustment procedure not only for display of regular signals but also for that of video signals and large duty cycle ratio signals.

(5) 20-MHz dual-channel real time oscilloscope

The DSS5020 is a version of the COS5020 whose performance has been proven. The DSS5020 can be used as a quality real time oscilloscope.

(6) Compact, light, but sturdy

The mainframe of the DSS5020 is made of aluminium dicast and steel plates. It is compact, light, but sturdy.

2. SPECIFICATIONS

(1) Vertical axes

o Non-storage mode (The same applies also to the storage mode unless specified otherwise.)

Item	Specification	Remarks
Sensitivity	NORM: 5 mV - 5 V/DIV ×5 MAG: 1 mV - 1 V/DIV	1-2-5 sequence, 10 ranges
Sensitivity accuracy	NORM: ±3% or better ×5 MAG: ±5% or better	10 to 35°C (50 to 95°F), 1 kHz, at 4 or 5 DIV
Vernier vertical sensitivity	To 1/2.5 or less of panel-indicated value	
Frequency bandwidth	NORM: DC - 20 MHz, within -3 dB ×5 MAG: DC - 15 MHz, within -3 dB AC coupling: Low limit frequency 10 Hz, -3 dB	With reference to 50 kHz, 8 DIV Otherwise if in storage mode
Rise time	NORM: Approx. 17.5 nsec ×5 MAG: Approx. 23 nsec	Otherwise if in storage mode
Input impedance	1 MΩ ±2%, 25 pF ±2 pF	
Square wave characteristics	Overshoot: Not greater than 5% Other distortions: Not greater than 3% (At 10 mV/DIV range) (Other ranges: 3% added to the above values)	10 to 35°C (50 to 95°F) Applicable to non-storage mode only
DC balance shift	NORM: ±0.5 DIV or less ×5 MAG: ±2.0 DIV or less	
Linearity	±0.1 DIV or less of amplitude change when waveform of 2 DIV at graticule center is moved vertically	

Item	Specification		Remarks
Display modes	CH1	CH1 single channel	
	CH2	CH2 single channel	
	DUAL	CHOP: 1 sec - 1 msec/DIV ALT: 0.5 msec - 0.5 µsec/DIV	
	ADD	CH1 ± CH2	
Chopping repetition frequency	200 kHz ±0.02%		Otherwise if in storage mode
Input coupling	AC/GND/DC		
Maximum allowable input voltage	400 V (DC + AC peak)		AC: 1 kHz or lower
Common mode rejection ratio	50:1 or better at 50 kHz, sinusoidal wave		
Isolation between channels	At least 1000:1 at 50 kHz At least 30:1 at 20 MHz		30:1 (20 MHz) is for storage mode only.
CH1 signal output	Approx. 100 mV/DIV when open; approx. 50 mV/DIV when 50-ohm termination		
CH2 INV BAL	Balanced point variation: 1 DIV or less (at center of graticule)		

o Storage mode

Item	Specification	Remarks
A/D converter	8-bit half-flush type	
Maximum sampling speed	1M samples/sec	
Vertical resolution	8 bits, 28 points/DIV, 9.14 DIV dynamic range	
Sensitivity accuracy	NORM: (±3%) + 1 LSB or better ×5 MAG: (±5%) + 1 LSB or better	
Effective storage bandwidth	NORM: DC - 400 kHz ×5 MAG: DC - 400 kHz	When sinusoidal interpolation is used
Effective rise time	1.6 μsec or faster	When pulse interpolation is used
Chopping repetition frequency	50 Hz - 50 kHz, depending on TIME/DIV range	

(2) Triggering

o Non-storage mode (The same applies also to the storage mode unless specified otherwise.)

Item	Specification	Remarks
Triggering source	CH1, CH2, LINE, and EXT (CH1 and CH2 can be selected only when the vertical mode is DUAL or ADD. In other cases, triggering source is automatically selected by the VERT MODE switch.)	
Coupling	AC, HF REJ, TV, DC	
Polarity	+ or -	

Item	Specification	Remarks
Sensitivity	DC - 10 MHz: 0.5 DIV (0.1 V) DC - 20 MHz: 1.5 DIV (0.2 V) Video signal: 2.0 DIV (0.2 V) AC coupling: Attenuates signal components of lower than 10 Hz HF REJ: Attenuates signal components of higher than 50 kHz	The values enclosed in the parentheses are the input sensitivities when in the EXT triggering mode. The specifications of DC - 10 MHz and DC - 20 MHz are applicable to non-storage mode only.
Triggering modes	AUTO: Sweep runs in the free mode when no triggering input signal is applied.	
	NORM: When no triggering signal is applied, the trace is in the READY state and not displayed.	Otherwise if in storage mode
	SINGLE: One-shot sweep with triggering signal. Can be reset to the READY state by means of RESET switch. The READY lamp (LED) turns on when in the READY state or in the sweep operation.	Otherwise if in storage mode
LEVEL LOCK	Satisfies the value of the above trigger sensitivity plus 0.5 DIV (0.05 V) for signal of duty cycle 20:80 and repetition frequency 50 Hz - 20 MHz.	Repetition frequency 50 Hz - 400 kHz if in storage mode
EXT triggering signal input	EXT HOR input terminal is used in common.	Applicable to non-storage mode only
Input impedance	1 MΩ ±2%, approx. 25 pF	
Maximum allowable input voltage	100 V (DC + AC peak)	AC frequency not higher than 1 kHz

o Storage mode

Item	Specification	Remarks
Triggering sensitivity	DC - 400 kHz: 0.5 DIV (0.1 V)	
Triggering modes	NORM: When triggering has become ineffective, the displayed waveform remains as saved with previous triggering and the circuit remains ready to accept triggering.	If in the ROLL mode, newly stored waveform is displayed even when in the READY state.
	SINGLE: Waveform for one-shot sweep caused by triggering is automatically saved. When saving is reset, the circuit again becomes the READY state. The READY lamp (LED) turns on when in the READY state or in sweep operation.	If in the ROLL mode, newly stored waveform is displayed even when in the READY state.
Predelayed triggerin point	Horizontal: 2 DIV, 5 DIV, or 8 DIV point	
Jitter canceller operating frequency	Approx. 30 kHz	

(3) Horizontal axis (time base)

o Non-storage mode (The same applies also to the storage mode unless specified otherwise.)

Item	Specification	Remarks
Sweep time	NORM: 0.5 µsec - 1 sec/DIV ×10 MAG: 50 nsec - 0.1 sec/DIV	1-2-5 sequence, 20 ranges
Sweep time accuracy	NORM: ±3% ×10 MAG: ±5% 0.5 µsec/DIV range alone when in non-storage mode: ±8%	10 to 35°C (50 to 95°F)
Vernier sweep time control	To 1/2.5 or slower of panel-indicated value	Applicable to non-storage mode only

Item	Specification	Remarks
Holdoff time adjustment range	Continuously variable to 2 times or over of sweep length (time) at 0.5 µsec - 1 msec/DIV ranges	Applicable to non-storage mode only
Sweep magnification	10 times	
Linearity	NORM: ±3% ×10 MAG: ±5% 0.5 µsec/DIV range alone when in non-storage mode: ±8%	
Position shift caused by sweep magnification	Within 1 DIV at CRT screen center	
X-Y mode	X-azis: CH1 input signal Y-axis: CH2 input signal	Applicable to non-storage mode only
X-axis sensitivity	Same as CH1 vertical axis	
Sensitivity accuracy	NORM: ±4% 10 to 35°C (50 to 95°F) ×5 MAG: ±6%	
Frequency bandwidth	DC - 1 MHz (-3 dB)	
X-Y phase difference	Not greater than 3° at DC - 50 kHz	
EXT HOR mode	Trace swept by an external horizontal signal applied to the EXT TRIG IN terminal. Vertical axis modes are CH1, CH2, DUAL and ADD modes (indicated).	Applicable to non-storage mode only
Sensitivity	Approx. 0.1 V/DIV	
Frequency bandwidth	DC - 1 MHz (-3 dB)	
Phase difference between vertical axes	Within 3° (at DC - 50 kHz)	

o Storage mode

Item	Specification	Remarks
Horizontal resolution	10 bits/channel, 100 points/bit, 1024 points	
Sampling speed	100 samples/sec - 1M samples/sec	Sampling speed at 1 sec - 0.1 msec/ DIV depends on TIME/DIV setting. At 50 µsec - 0.5 µsec/DIV, sampling speed is fixed at 1M samples/sec and waveform is expanded by interpolation.
Accuracy of sampling speed	0.02% or better	
ROLL mode	Automatic switching of 1 sec - 0.1 sec/DIV ranges	
Time base magnification by interpolation	Up to 100 times of time base on which data has been saved (up to 200 times when data is saved on 0.1 msec/DIV range) from the above time base	Magnification is done with reference to the position selected by trigger- ing point.
Types of interpolation	Sine interpolation and pulse interpolation	
Processing time	Pulse interpolation Average: 0.067 sec/channel Maximum: 0.2 sec/chann31 Sine interpolation Average: 0.7 sec/channel Maximum: 2.4 sec/channel	
SAVE mode	As you press the SAVE switch, the oscilloscope is set to the SAVE mode and data being acquired is saved.	
REFERENCE	As you press the REF switch, data is stored with reference to the waveform currently dis- played on the CRT screen. AS you press the REF switch again, the REFERENCE state is released.	Not applicable when in the DUAL mode

Item	Specification	Remarks
Storing interval	Approx. 0.5 sec - 5 sec, continuously variable	Excluding arithmetic processing time

(4) Z axis

Item	Specification	Remarks
Sensitivity	3 Vp-p (Trace becomes brighter with negative input.)	
Frequency range	DC - 5 MHz	
Input resistance	Approx. 5 kΩ	
Allowable input voltage	50 Vp-p (DC + AC peak)	AC frequency not higher than 1 kHz

(5) Calibration voltage

Item	Specification	Remarks
Waveform	Positive square wave	
Frequency	1 kHz ±20%	
Duty ratio	Within 45:55	
Output voltage	2 Vp-p, ±2%	
Output resistance	Approx. 2 kΩ	

(6) CRT

Item	Specification	Remarks
Type	6-inch rectangular type, internal graticule	
Phosphor	P31	
Acceleration voltage	Approx. 2 kV	
Effective screen size	8 × 10 DIV	1 DIV = 10 mm (0.39 in.)
Graticule	Internal graticule; continuously adjustable illumination	

(7) Line power requirements

Voltage: 100 V, 115 V, 215 V, 230 V; with ±10% allowance.
Selectable by connector change

Frequency: 50 Hz or 60 Hz

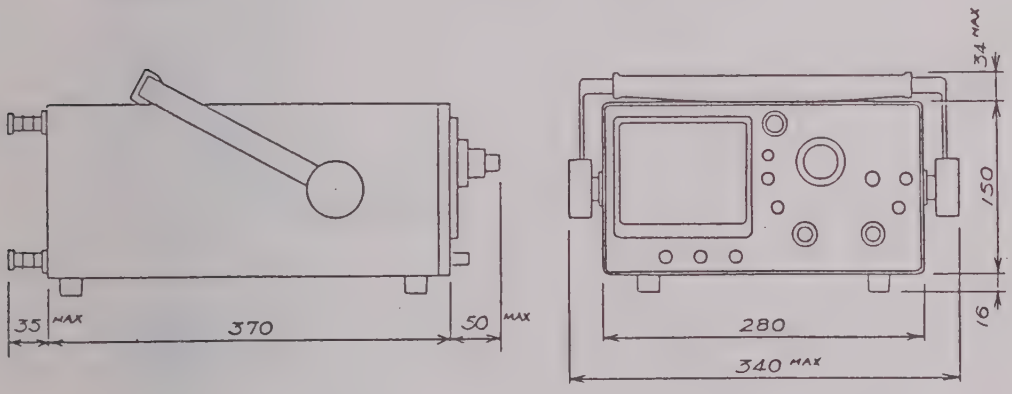
Power consumption: Approx. 48 VA

(8) Mechanical specifications

Mainframe dimensions: 280 W × 150 H × 370 D mm
(11.02 W × 5.91 H × 14.57 D in.)

Maximum dimensions: 340 W × 200 H × 455 D mm
(13.39 W × 7.87 H × 17.91 D in.)

Weight: Approx. 6.8 kg (15 lbs)



(9) Operating environment

To satisfy specifications: 5 to 35°C (41 to 95°F), 85% RH

Maximum operating ranges: 0 to 40°C (32 to 104°F), 90% RH

(10) Accessories

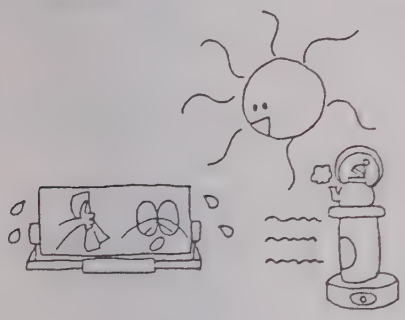
P060-S probes (10:1, 1:1, 1.5 m)	2
942A terminal adaptors	2
Power cord	1
Instruction manual	1

o Specifications and contents on this manual are subject to change without notice.

3. GENERAL PRECAUTIONS

o Environments

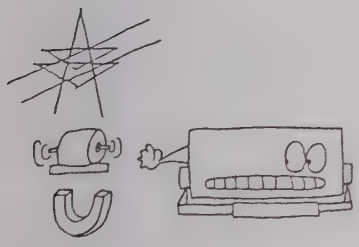
Avoid exposing the oscilloscope to unfavorable environments as follows:



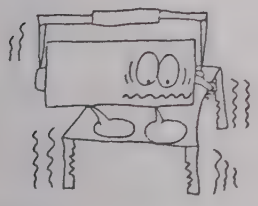
- Direct sunlight or other hot place of 40°C (104°F) or over

- Rapid temperature change

- Cold place of 0°C (32°F) or below

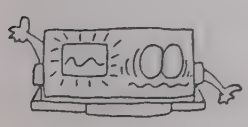


- Strong magnetic or electric field



- Unreasonably large mechanical vibration

o CRT intensity



- In order to prevent permanent damage to the CRT phosphor, do not make the CRT trace excessively bright or leave the spot stationary for an unreasonably long time.

o Unpacking the Oscilloscope

The oscilloscope is shipped from the factory after thoroughly inspected and tested. Upon receipt of the instrument, immediately unpack and inspect it for any damage which might have been sustained when in transportation. If any sign of damage is found, immediately notify the bearer and/or the dealer.

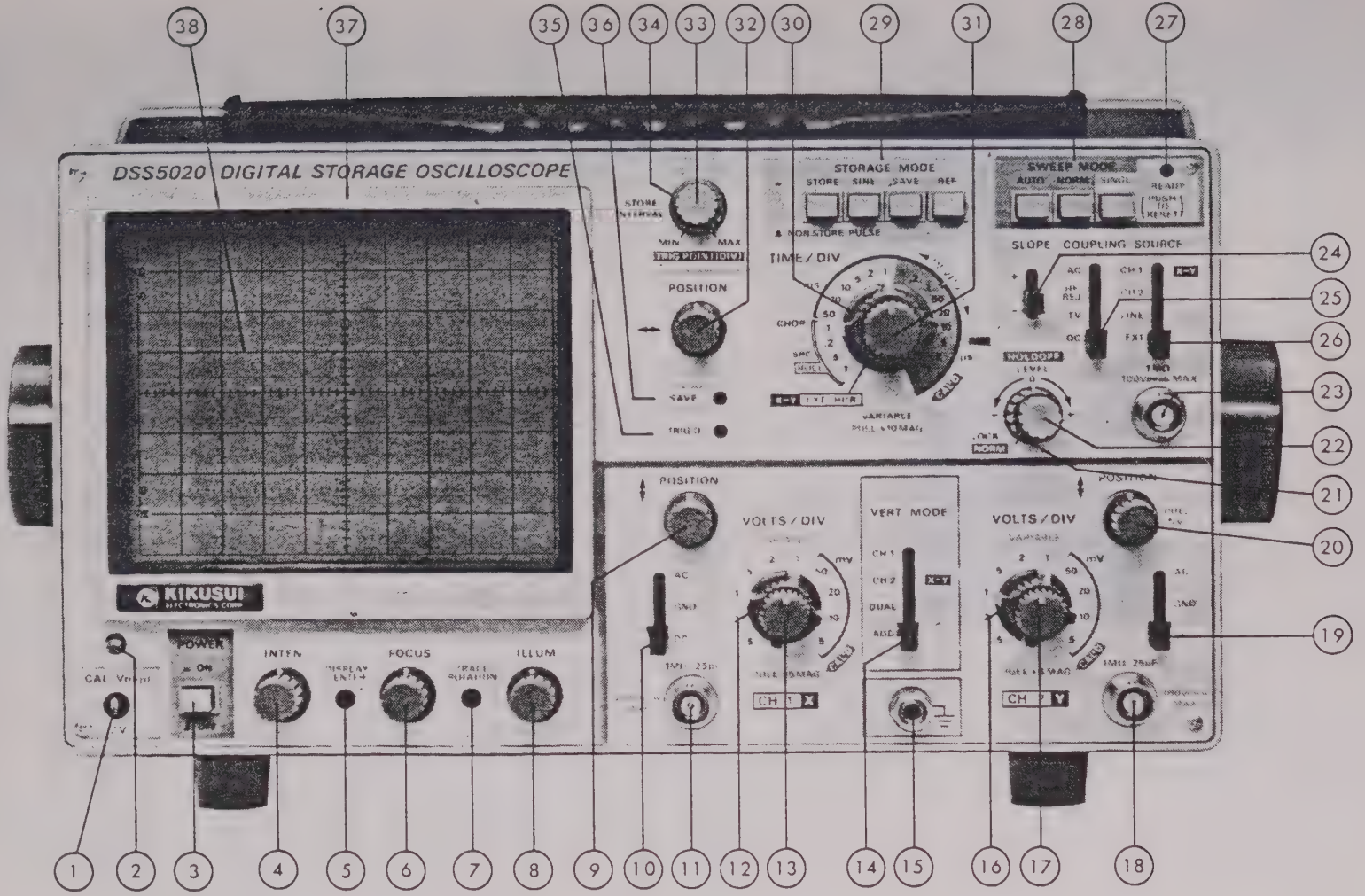
o Checking the Line Voltage

The oscilloscope can operate on any one of the line voltages shown in the below table, by inserting the line voltage selector plug in the corresponding position on the rear panel. Before connecting the power plug to an AC line outlet, be sure to check that the voltage selector plug is set in the correct position corresponding to the line voltage. Note that oscilloscope may not properly operate or may be damaged if it is connected to a wrong voltage AC line. When line voltages are changed, replace fuses also as required.

Selector plug position	Nominal voltage	Voltage tolerance	Fuse
A	100 V	90 - 110 V	1 A
B	115 V	104 - 126 V	
C	215 V	194 - 236 V	0.5 A
D	230 V	207 - 253 V	

o Resetting the Oscilloscope

When an erroneous operation (erroneous setting) of the oscilloscope is suspected, reset it by turning OFF power once and then turning it ON again. This will reset the oscilloscope (CPU) to the normal state. If it is not reset, contact your Kikusui agent for service.


DSS5020 DIGITAL STORAGE OSCILLOSCOPE
KIKUSUI
STORAGE MODE
STORE SINE SAVE REF
SWEEP MODE
AUTO NORM SINGL
READY
SLOPE COUPLING SOURCE
TIME/DIV
POSITION
VOLTS/DIV
VERT MODE
CH1
CH2
DUAL
ADD
X-Y
POWER
INTEN
FOCUS
ILLUM
TRIG LEVEL
HOLDOFF
SAVE
TRIG'D
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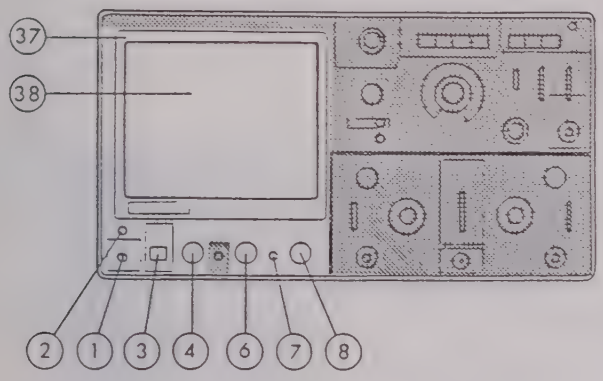
4. DESCRIPTION OF PANELS

4.1 Description of Front Panel

o Power Switch o CRT Controls o CAL Adjustments



CAL (Vp-p) ..... (1) This terminal delivers the calibration voltage of 2 Vp-p, approximately 1 kHz, positive square wave. The output resistance is approximately 2 kΩ.

POWER ..... (3) Main power switch of the instrument. When this switch is turned on, the LED 2 above the switch also is turned on.

INTEN ..... (4) Controls the brightness of the spot or trace.

FOCUS ..... (6) For focusing the trace to the sharpest image.

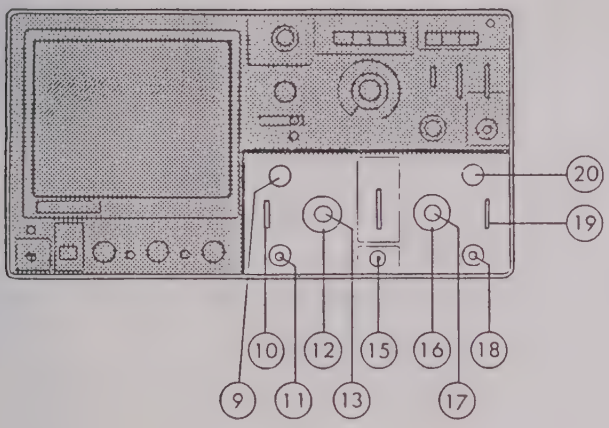
TRACE ROTATION ... (7) Potentiometer (driver adjustment type) for aligning the horizontal trace in parallel with graticule lines.

ILLUM ..... (8) Graticule illumination adjustment.

Bezel ..... (37) For installing a camera mount in one-touch operation.

Filter ..... (38) Blue filter for ease of waveform viewing. Can be removed in one-touch operation.

o Vertical Axes



CH1 (X) input ..... (11) Vertical input terminal of CH1. During X-Y operation, this becomes X-axis (abscissa) input terminal.

CH2 (Y) input ..... (18) Vertical input terminal of CH2. During X-Y operation, this becomes Y-axis (ordinate) input terminal.

AC-GND-DC ..... (10)(19) Switch for selecting connection mode between input signal and vertical amplifier.

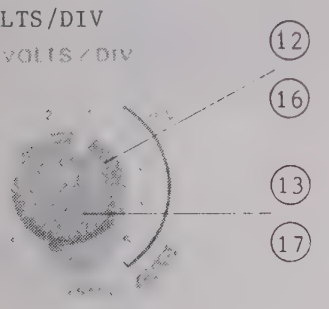
AC: AC coupling

GND: Vertical amplifier input is grounded and input terminals are made open.

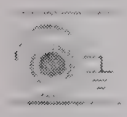
DC: DC coupling

VOLTS/DIV ..... (12)(16) Select the vertical axis sensitivity, from 5 mV/DIV to 5 V/DIV with 10 ranges.

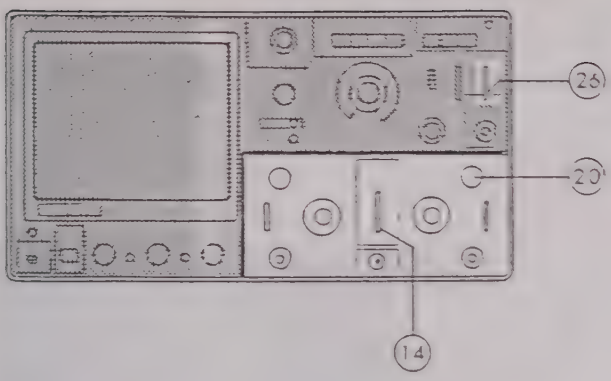
VARIABLE ..... (13)(17) Fine adjustment of sensitivity, to a factor of 1/2.5 or more of the panel-indicated value. At the CAL'D position, sensitivity is calibrated to the panel-indicated value. When this knob is pulled out (×5 MAG state), the amplifier sensitivity is multiplied by 5 times.



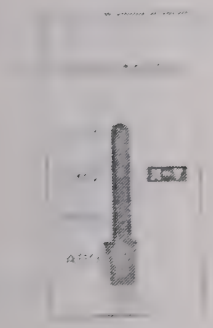
POSITION ..... (9)(20) Vertical positioning control of trace or spot.



..... (15) Ground terminal of oscilloscope mainframe.



VERT MODE ..... (14) Selects operation modes of CH1 and CH2 amplifiers. Also selects internal triggering source signal.



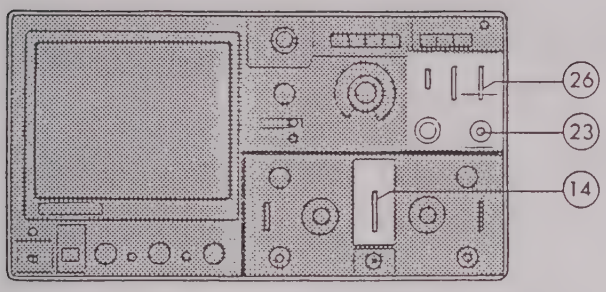
CH1: The oscilloscope operates as a single-channel instrument with CH1 alone. The CH1 input signal is used as the internal triggering source signal.

CH2: The oscilloscope operates as a single-channel instrument with CH2 alone. The CH2 signal is used as the internal triggering source signal.

DUAL: The oscilloscope operates as a dual-channel instrument with both CH1 and CH2. The internal triggering source signal is selected by SOURCE switch (26).

ADD: The oscilloscope displays the algebraic sum (CH1 + CH2) or difference (CH1 - CH2) of the two signals. The pulled out state of CH2 POSITION knob (20) provides the difference (CH1 - CH2). The internal triggering source signal is selected by SOURCE switch (26).

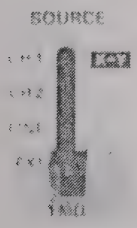
Note: If selection is changed for data saved in the storage mode, an error state is caused and the display blinks.



EXT TRIG (EXT HOR) .. (23)
input terminal

This terminal is used in common for external triggering signal and external horizontal signal. To use this terminal, set SOURCE switch (26) to the EXT position.

SOURCE ..... (26)



Selects the internal triggering source signal. Also select the EXT HOR input signal.

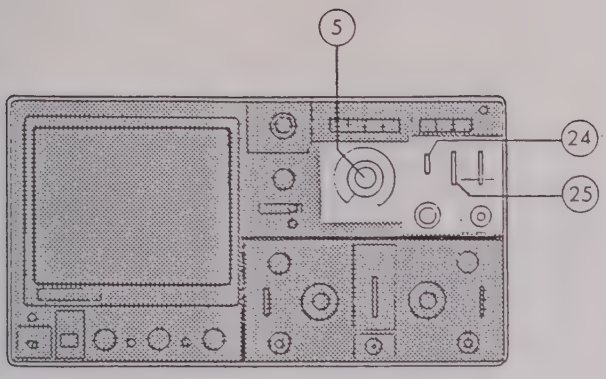
CH1 X-Y: When the VERT mode switch (14) is set at the DUAL or ADD position, selects CH1 for the internal triggering source signal. During the X-Y mode operation, selects CH1 for the X-axis signal.

CH2: When the VERT mode switch (14) is set at the DUAL or ADD position, selects CH2 for the internal triggering source signal.

LINE: Selects the AC line signal for the triggering source signal.

EXT: The external signal applied through EXT TRIG (EXT HOR) input terminal (23) is used for the external triggering source signal. During the X-Y, EXT HOR mode operation, the X-axis operates with the external sweep signal.

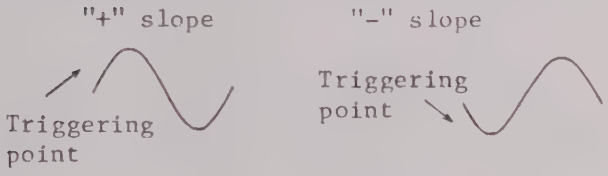
Note: When the VERT MODE switch is set to the CH1 or CH2 position, internal triggering source signal selection cannot be made by the SOURCE signal. That is to say, when in the single-sweep (one-shot) mode, an internal triggering source signal is selected by the VERT MODE switch.



SLOPE ..... (24) Selects the triggering slope.

"+": Triggering occurs when the triggering signal crosses the triggering level in the positive-going direction.

"-": Triggering occurs when the triggering signal corsses the triggering level in the negative-going direction.



COUPLING ..... (25) Selects coupling mode between triggering source signal and trigger circuit; selects connection of TV sync trigger circuit.

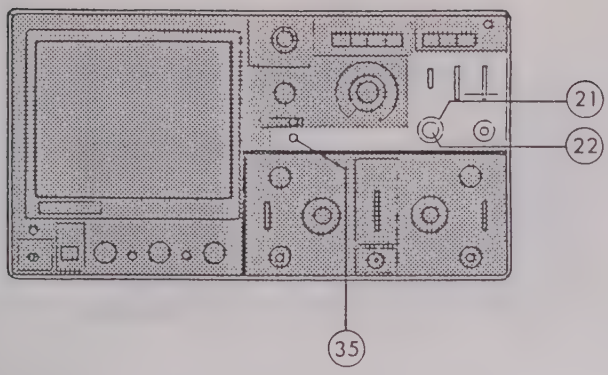
AC: AC coupling

HF REJ: AC coupling, with components higher than 50 kHz rejected.

TV: The trigger circuit is connected to the TV sync separator circuit and the sweeps are synchronized with the TV V or TV H signal at a rate selected by the TIME/DIV switch (30).

TV V: 0.5 sec/DIV - 0.1 msec/DIV.
TV H: 50 µsec/DIV - 0.2 µsec/DIV.

DC: DC coupling



HOLDOFF ..... (21)
LEVEL ..... (22)

These double-knob controls are for holdoff time adjustment and triggering level adjustment.

The HOLDOFF time control is used when the signal waveform is complex and stable triggering cannot be attained with LEVEL knob (22) alone.

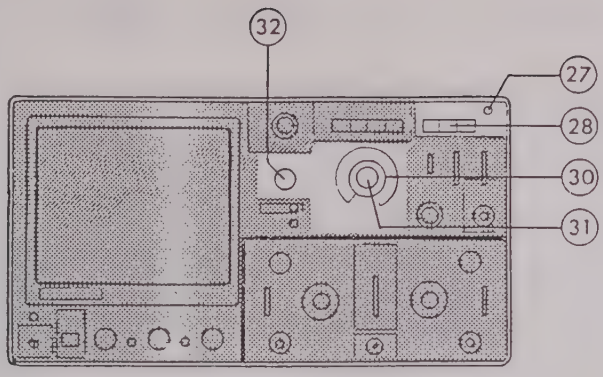
The LEVEL knob is for displaying a synchronized stationary waveform and setting a start point for the waveform.

As this knob is turned in "→ +" direction, the triggering level moves upward on the displayed waveform; as the knob is turned in "- ←", the triggering level moves downward.

When set at the LOCK position, the triggering level is automatically maintained at the optimum value irrespective of the signal amplitude (from very small amplitude to large amplitude), requiring no manual adjustment of triggering level.

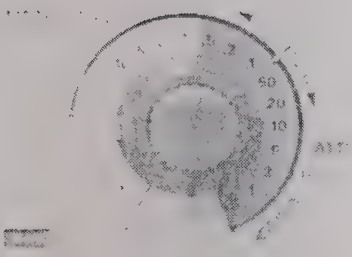
When triggered, the lamp (35) illuminates.

o Horizontal axis(time base)



TIME/DIV ..... (30)

Selects the sweep time. When this switch is set to the X-Y EXT HOR position, the oscilloscope operates as an X-Y scope with CH1 for the X-axis or operates in the EXT HOR mode with an external sweep input signal for the horizontal signal.



(30)

(31)

VARIABLE ..... (31)

PULL ×10 MAG

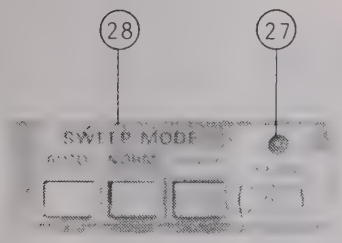
Vernier control of sweep time and ×10 MAG switch. (This control remains idle when in the storage mode.) The sweep time can be made slower by a factor of 2.5 or more of the panel-indicated value.

The panel-indicated values are calibrated with this knob set in the CAL'D position.

The pulled out position of this knob is for the ×10 MAG state.

POSITION ..... (32) Vertical adjustment of the trace or spot.

SWEEP MODE ..... (28) Selects the desired sweep mode.



AUTO: When no triggering signal is applied or when triggering signal frequency is less than 50 Hz, sweep runs in the free run mode.

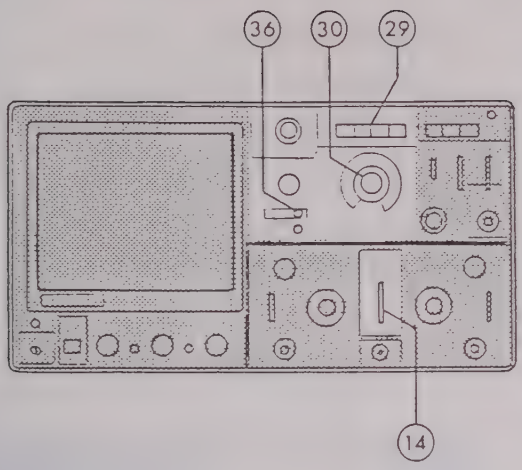
NORM: When no triggering signal is applied, sweep is in a ready state and the trace is blanked out. Used primarily for oberva-tion of signals of 50 Hz or lower.

SINGLE: Used for single sweep operation (one-shot sweep operation), and in common as the reset switch.

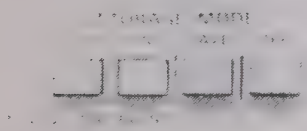
PUSH TO RESET

When the three buttons are in the pushed out state, the circuit is in the single sweep mode. The circuit is reset as this button is pressed. When the circuit is reset, the READY lamp (27) turns on. The lamp goes off when the single sweep operation is over.

o Storage Mode



STORAGE MODE ..... (29) These switches are for selection between storage mode and non-storage mode, and for selection of the various functions in the storage mode.



STORE/NON-STORE:

The pushed-out state is for the non-storage mode and the DSS5020 operates as a real time oscilloscope. The pushed-in state is for the storage mode and the DSS5020 operates as a digital storage oscilloscope.

SINE/PULSE:

To select an interpolation mode for data measured with ranges 50 µsec/DIV - 0.5 µsec/DIF of TIME/DIV switch (30). Effective also when saved data is magnified.

The pushed-out state is for pulse interpolation for viewing of linear waveforms such as pulse waves.

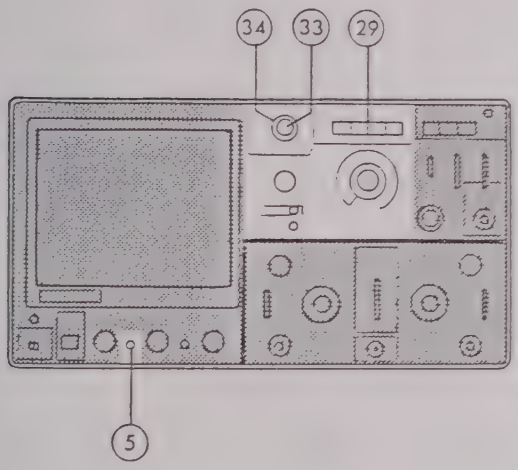
The pushed-in state is for sine interpolation. Signals which do not involve frequency components higher than 400 kHz can be accurately displayed.

SAVE:

The displayed waveform is saved, storing of data is halted, and the SAVE lamp (36) turns on. The saved waveform can

be displayed being magnified up to 100 times by interpolation with the TIME/DIV switch (30).

Note: If the reproduced waveform is with a TIME/DIV range slower than that used for saving or faster than 100 times (except the 0.1 msec/DIV range), the displayed waveform blinks to indicate the erroneous state. It blinks also if the VERT MODE switch (14) is changed when saving the waveform.



SAVE REF (29) :

If this button is pressed, the waveform displayed on the CRT at the moment is saved as reference and the data stored subsequently can be sequentially compared with the reference data.

STORE INTERVAL (33)

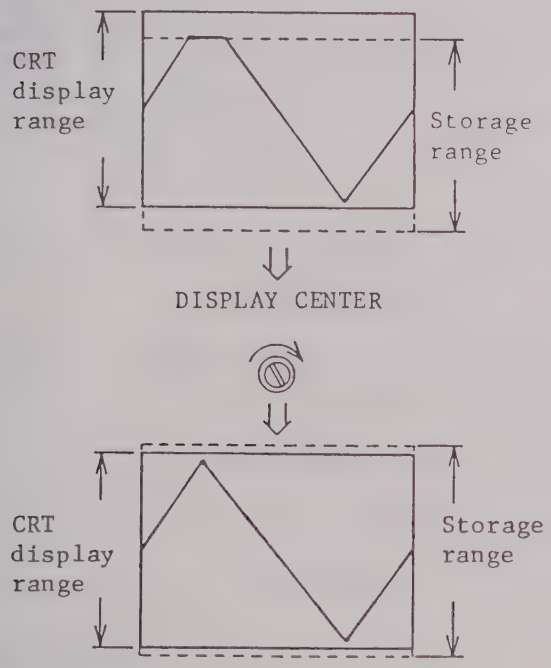
To adjust intervals of data storing. The counterclockwise extreme position is for continuous storing. As this control is turned clockwise, the storing interval is adjustable continuously-variably for a range of 0.5 sec to 5 sec.

TRIG POINT (DIV) (34)

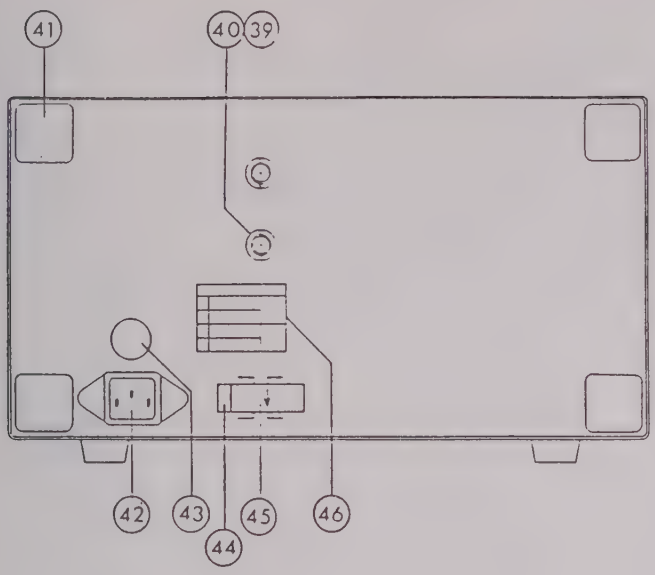
To select a triggering point to view waveform which existed before the triggered point. Selectable for a range of 2, 5, or 8 DIV.

DISPLAY CENTER (5)

Due to terrestrial magnetism or other external cause, the display range on the CRT may not conform with the storage range and some parts of the displayed waveform may be clipped. In such a case, the overall waveform can be moved by this control so that the CRT display range conforms with the storage range. The overall waveform moves upward as this control is turned clockwise, and vice versa.



4.2 Description of Rear Panel



- o Z AXIS INPUT ..... (39) Input terminals for external intensity modulation signal.

- o CH1 SIGNAL OUTPUT ... (40) Delivers the CH1 signal with a voltage of approximately 100 mV per 1 DIV of graticule. When terminated with 50 ohms, the signal is attenuated to about a half. May be used for frequency counting, etc.

- o AC Power Input Circuit

  AC power input connector ... (40)

  Input connector of the AC power of the instrument. Connect the AC power cord (supplied) to this connector.

  FUSE ..... (43) Fuse in the primary circuit. Fuse rating is as shown in Table (46).

  AC voltage selecting connector ... (44)

  For selecting the AC voltage of the instrument.

AC voltage selector plug ... (45)

For selecting the AC voltage of the instrument by aligning its arrowhead mark in the corresponding position as shown in Table (46).

Studs ..... (41) Studs for laying the oscilloscope in the vertical upward posture. Also used to take up the power cord.

5. BASIC OPERATION METHOD

5.1 AC Line Voltage Setting

Before connecting the power cord to an AC line outlet, check that the oscilloscope has been correctly set for the AC line voltage with the AC line voltage selector plug (45) on the rear panel of the oscilloscope. (Refer to 4.2 "Description of Rear Panel.")

5.2 To Display a Trace on the CRT

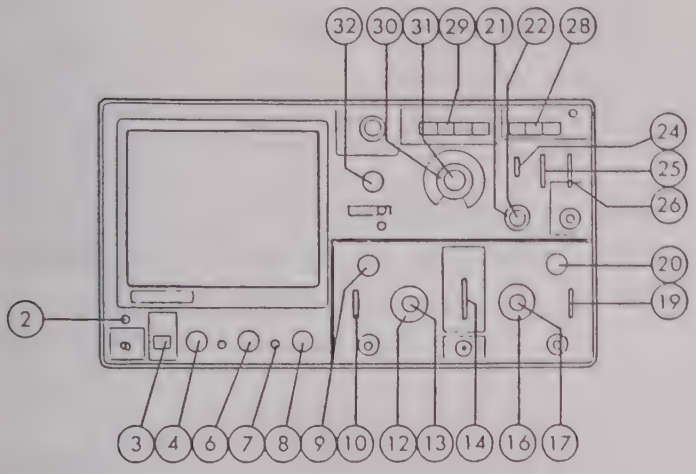
1) Set the switches and controls as shown in Table 5-1.

Table 5-1

Switch or Control		Setting	
POWER	(3)		OFF position
INTEN	(4)		3-o'clock position
FOCUS	(6)		Mid-position
ILLUM	(8)		CCW position
VERT MODE	(14)		CH1
‡ POSITION	(9) (20)		Mid-position, pushed in
VOLTS/DIV	(12) (16)		50 mV/DIV
VARIABLE	(13) (17)		CAL'D (CW) position, pushed in
AC-GND-DC	(10) (19)		GND
SOURCE	(26)		CH1
COUPLING	(25)		AC
SLOPE	(24)		+
LEVEL	(22)		LOCK (CCW)
HOLD OFF	(21)		NORM (CCW)
SWEEP MODE	(28)		AUTO
STORE/NON-STORE	(29)		NON-STORE

To be continued

Switch or Control		Setting	
TIME/DIV	(30)		0.5 ms/DIV
VARIABLE	(31)		CAL'D (CW) position, pushed in
↔ POSITION	(32)		Mid-position



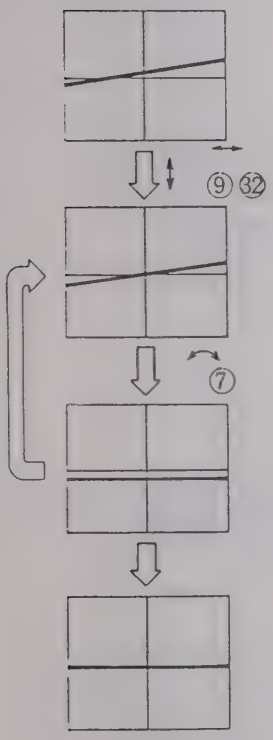
2) After setting the switches and controls as above, connect the power cord to the AC line outlet.

3) Turn on (push in) the POWER switch (3) and check that the power indicator lamp (LED) (2) at upper left of the power switch turns on. In about 20 seconds, a trace will appear on the CRT screen. If no trace appears even after about 60 seconds, repeat the switch and control settings shown in Table 5-1.

4) Adjust the trace to an appropriate brightness and to the sharpest image with the INTEN control (4) and FOCUS control (6).

5.3 To Align the Trace with the Graticule Line

If the displayed trace is not aligned with the horizontal graticule line at the center of the graticule due to terrestrial magnetism or other cause, align the trace as follows:



1) Connect the CH1 vertical input terminal to the GND terminal and display a horizontal trace. Assume that the trace is not aligned with the graticule line as illustrated.

2) Align the center of the trace with that of the graticule by adjusting the vertical POSITION control (9) and horizontal POSITION control (32).

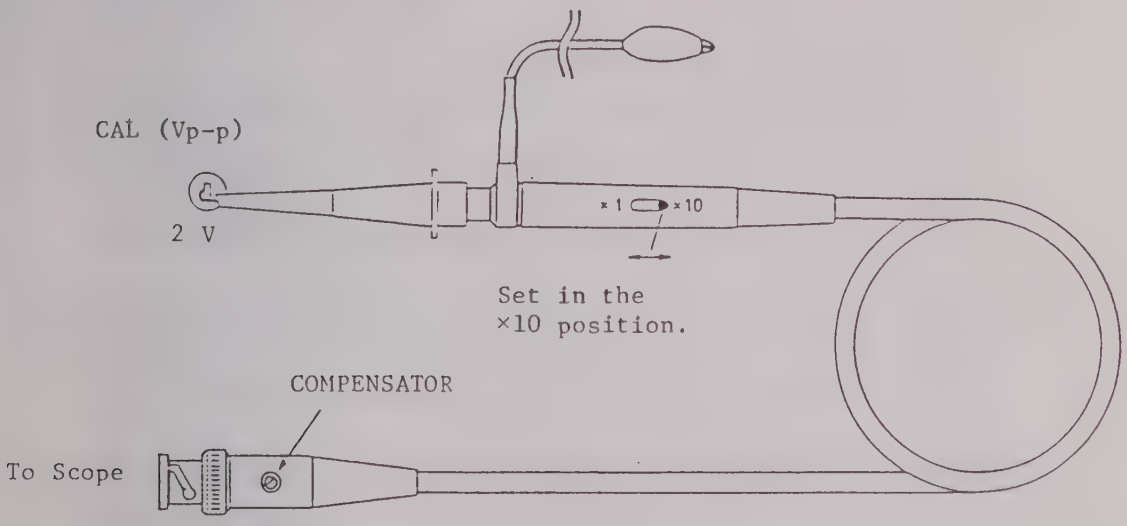
3) Make the trace parallel with the horizontal graticule line by adjusting the TRACE ROTATION control (7) using a screwdriver.

4) If the trace is not aligned with the graticule line yet, repeat the procedures of 2) and 3) until the trace is precisely aligned.

Note: Be sure to check the above alignement each time the operating position (direction) of the oscilloscope is changed.

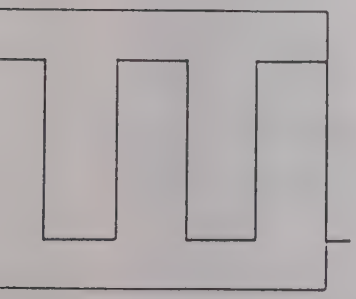
5.4 Calibration of Probe

The probe is a wide-range attenuator. Unless phase compensation is properly done, the displayed waveform is distorted causing measurement errors. Therefore, the probe must be properly calibrated before use. Calibration can be done by using the signal of the CAL (Vp-p) terminal (1) of the front panel.

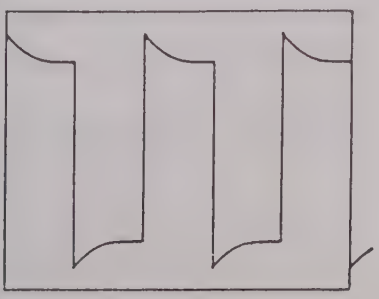


Connect the probe to the INPUT terminal of CH1 or CH2 and set VOLTS/DIV switch at 50 mV. Connect the probe tip to the calibration voltage output terminal and adjust the COMPENSATOR control with an insulated screwdriver so that an ideal waveform as illustrated below is obtained.

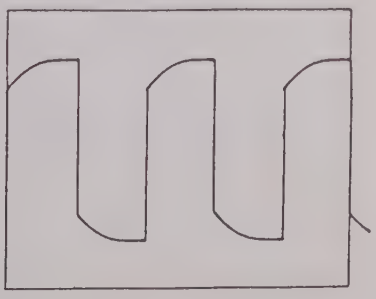
Ideal



Adjustment required



Adjustment required



6. MEASUREMENTS OF WAVEFORM

6.1 Measurement in Non-storage Mode

This section describes the operation method of the DSS5020 in the non-storage mode as a regular real-time oscilloscope.

1 Single-channel Operation

The operation method described hereunder is for single-channel measurement with CH1. Measurement with CH2 can be done by substituring CH1 by CH2 in the following description.

1) Set the switches and control as shown in Table 5-1.

2) Connect to the CH1 INPUT terminal (11) the accessary probe with its switch set to the ×10 position. Apply to the probe the 2-volt calibration signal from the CAL (Vp-p) terminal (1).

3) Set the AC-GND-DC switch (10) to the AC position. A waveform as shown in Figure 6-1 will be displayed.

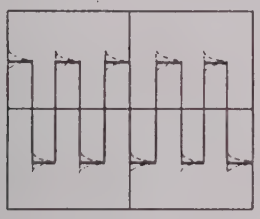


Figure 6-1

4) If the displayed waveform is not a pure pulse wave (⊓⊔) as indicated with the solid line but is a distorted pulse wave (⊓\ or /⊔) as indicated with a dotted line, calibrate the probe. (Refer to Section 5.4 "Calibration of Probe.")

5) Adjust the displayed waveform to the sharpest image with the FOCUS control (6).

6) For regular waveform viewing, adjust the displayed waveform to an adequate amplitude and an adequate number of peaks (cycles) with the VOLTS/DIV switch (12) and TIME/DIV switch (30).

7) Align the displayed waveform with the graticule lines by adjusting the ↕ POSITION control (9) and the ↔ POSITION control (32), and determine the voltage (Vp-p) and period (T).

Note: Note that no sweep may be displayed if a DC signal which contains no AC components is measured with the SWEEP MODE selector (28) set in the NORM state because no triggering will occur in this case.

2 Dual-channel Operation

1) Change the VERT MODE switch (14) to the DUAL position so that the other trace (CH2) also is displayed. (The trace explained in the preceding section was for CH1.) At this stage of procedure, the CH1 trace has the square wave of the calibration signal and the CH2 trace has a straight line since no signal is applied to this channel yet. See Figure 6-2.

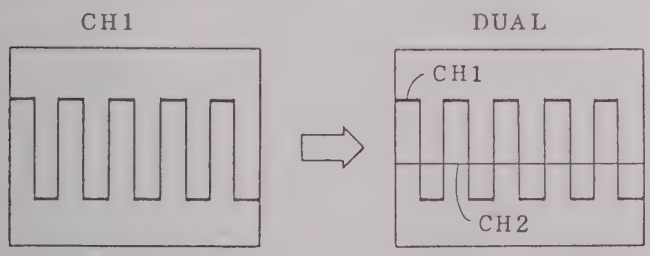


Figure 6-2

2) Apply the calibration signal also to the CH2 INPUT terminal (18) with the probe as is the case for CH1. Set the AC-GND-DC switch (19) to the AC position. Set the VOLTS/DIV switches (12) (16) to the 0.1 V/DIV range and adjust the ↕ POSITION controls (9) (20) so that dual channels of waveforms are displayed as shown in Figure 6-3.

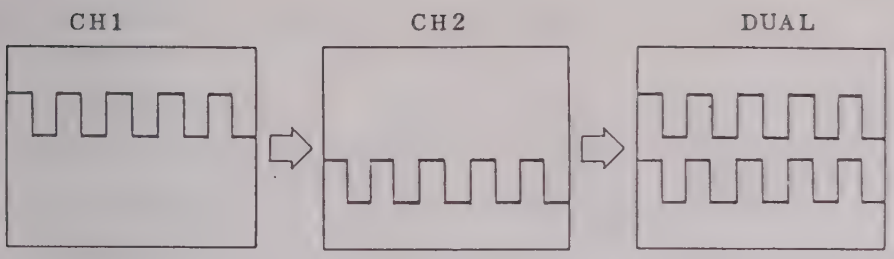
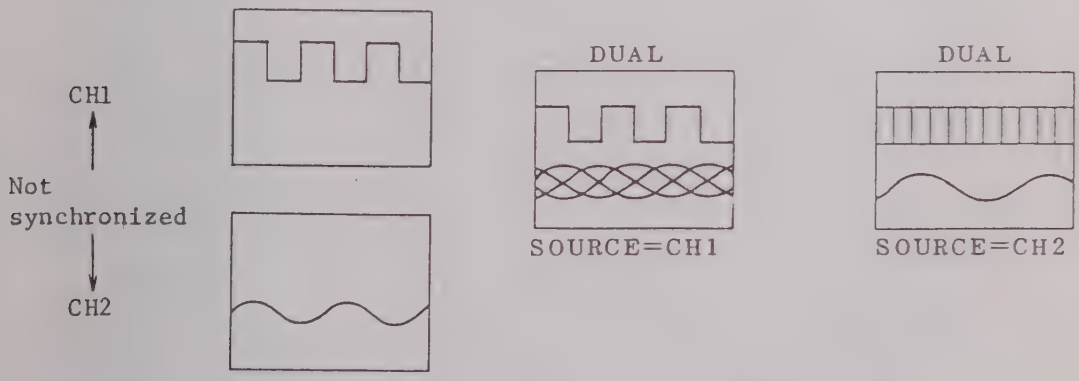


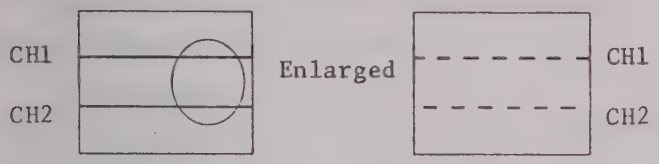
Figure 6-3

3) During the dual-channel operation (DUAL or ADD mode), either the CH1 or CH2 signal must be selected for the triggering source signal by means of the SOURCE switch (26). If both CH1 and CH2 signals are in a synchronized state, both waveforms can be displayed stationary; if not, only the signal selected by the SOURCE switch (26) can be displayed stationary.



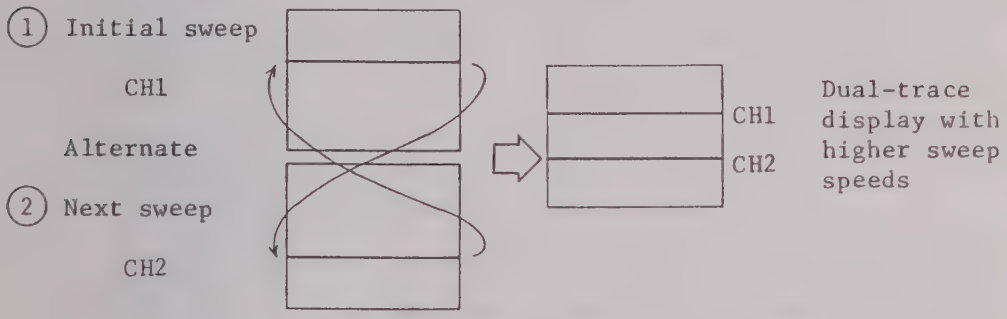
Note: Selection between CHOP mode and ALT mode is automatically made by the TIME/DIV switch (30). The 1 msec/DIV and lower ranges are used with the CHOP mode, and the 0.5 msec/DIV and higher ranges are used with the ALT mode.

CHOP mode for 1 msec/DIV and lower ranges:



Dual-trace disply with lower sweep speeds

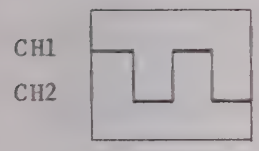
ALT mode for 0.5 msec/DIV and higher ranges:



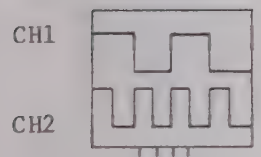
Dual-trace display with higher sweep speeds

3 To Add Two Waveforms

To display the sum of or difference between two waveforms, proceed as described in the following:

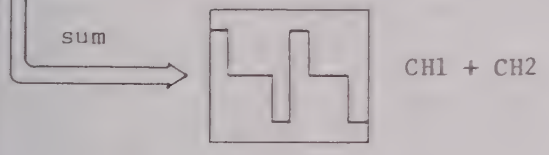


o Before displaying the sum or the difference, adjust equal the sensitivities of CH1 and CH2 by applying the same input to both channels and adjusting the VARIABLE controls (13) and (17). This adjustment should be done in the center of the CRT from the viewpoint of linearity of the vertical amplifiers.



o Algebraic sum:

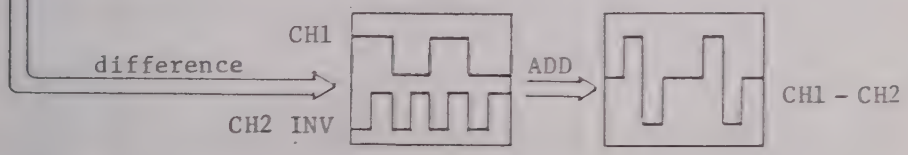
Set the VERT MODE switch (14) to the ADD position. The sum of CH1 and CH2 signals will be displayed on the CRT.



o Algebraic difference:

1) Set the CH2 POSITION control (20) to the PULL INV state so that the CH2 signal is displayed being inverted.

2) Set the VERT MODE switch (14) to the ADD position. The difference between CH1 and CH2 signals will be displayed on the CRT.



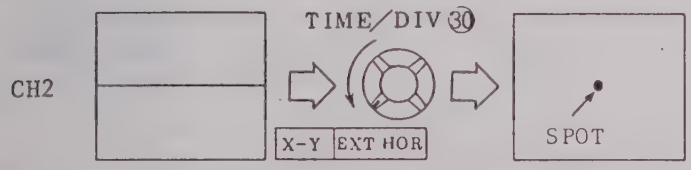
4 To Use as an X-Y Scope

The DSS5020 can be operated as a single-channel or dual-channel X-Y scope as selected by the VERT MODE switch (14).

o Single-channel X-Y operation

1) Set the VERT MODE switch (14) to the CH2 X-Y position.

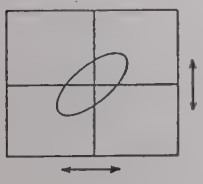
2) Set the TIME/DIV switch (30) to the X-Y EXT HOR position. The DSS5020 will operate as an X-Y scope.



3) Select an X axis with the SOURCE switch (26). In this case, select a Y axis with the VERT MODE switch (14) (except CH2) as shown in the following table.

SOURCE (26)	X axis	VERT MODE (14) Y axis
CH1 [X-Y]	CH1	CH2 [X-Y]
LINE	LINE	CH1 or CH2
EXT (external sweep)	EXT	CH1 or CH2

4) When the above setting is done, the DSS5020 will operate as a single-channel X-Y scope. The CH1 POSITION control (9) becomes idle and the horizontal POSITION control (32) operates as an X-axis POSITION control. For the Y axes, CH1 and CH2 POSITION controls (9) and (20) remain effective.

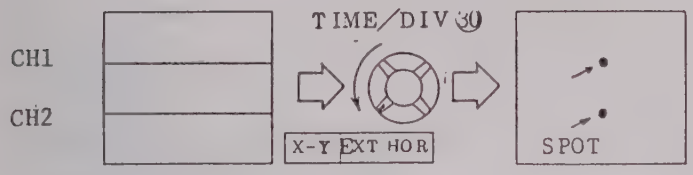


Y-axis: CH1 or CH2 POSITION controls (9) and (20)

X-axis: Horizontal POSITION control (32)

o Dual-channel X-Y operation

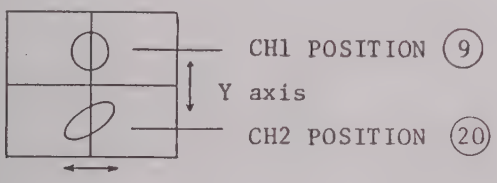
1) Set the VERT MODE switch (14) to the DUAL position. Then, set the TIME/DIV switch (30) to the | X-Y | EXT HOR position.



2) Select an X axis with the SOURCE switch (26) (except CH1 and CH2).

SOURCE (26)	X axis	Y axis
LINE	LINE	CH1 and CH2
EXT (external sweep)	EXT	CH1 and CH2

3) By the above setting, the DSS5020 operates as a dual-channel X-Y scope in the CHOP mode. The X axis is adjustable with the horizontal POSITION control (32) and the Y axes with the vertical CH1 and CH2 controls (9) and (20).



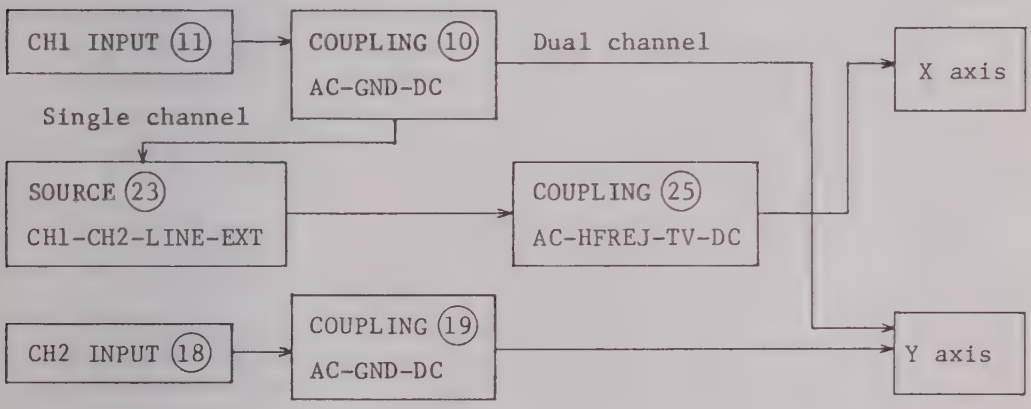
X axis: Horizontal POSITION (32)

o Frequency Bandwidths When in X-Y Mode

X axis: DC - 1 MHz (-3 dB)

Y axis: DC - 20 MHz (-3 dB)
When ×5 MAG: DC - 15 MHz (-3 dB)

Note: Note that, when in the X-Y mode, the X-axis signal is subjected to AC, HF REJ, or DC coupling as selected by the TRIG COUPLING switch (25) as well as by the AC-GND-DC switches (10) and (19).



Block Diagram When in X-Y Mode

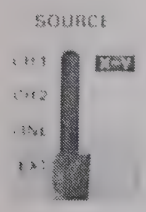
5 Triggering

Proper triggering is essential for efficient use of oscilloscopes. The DSS5020 has an internal trigger circuit for triggering with the input signal to be displayed or by the AC line signal and an external trigger circuit for triggering with an external signal which has a time relationship with the input signal to be displayed. Proper triggering methods are discribed in the subsequent paragraphs.

In general, the triggering procedure consists of the following four steps:

1) SOURCE (26) : Select a trigger source signal.
↓
2) COUPLING (27) : Select a coupling mode.
↓
3) SLOPE (24) : Select a triggering slope.
↓
4) LEVEL (22) : Adjust the triggering level.

1) Functions of SOURCE Switch (26)



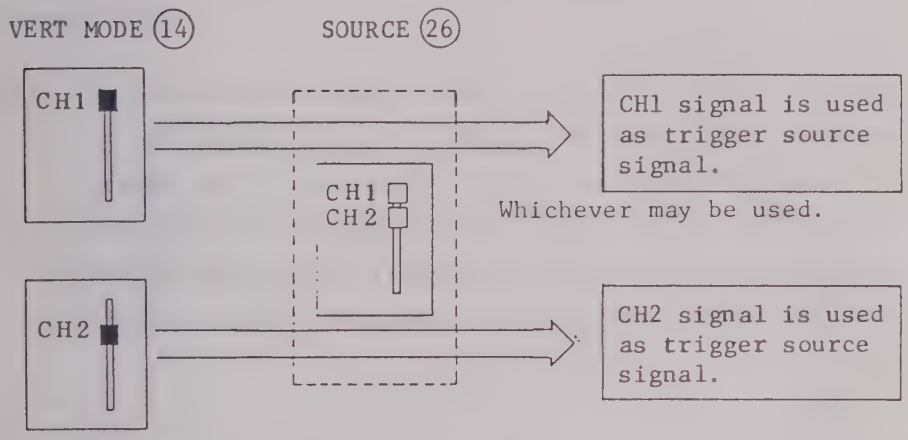
To display a stationary pattern on the CRT screen, the displayed signal itself or a trigger signal which has a time relationship with the displayed signal is required to be applied to the trigger circuit. The SOURCE switch (26) selects such a triggering source.

o Internal Trigger

CH1, CH2: This internal trigger method is used most commonly. The signal applied to the vertical input terminal 11 or (18) is branched off from the preamplifier and is fed to the trigger circuit. Since the triggering signal is the measured signal itself, a very stable waveform can be readily displayed on the CRT screen.

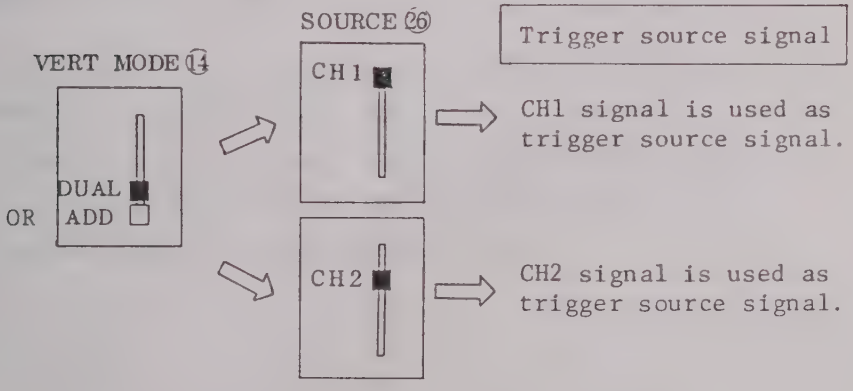
Single-sweep operation with CH1 or CH2

During the single-sweep mode operation, the signal of the channel selected by the VERT MODE switch (14) is used as the triggering source signal.



Dual-channel operation with CH1 and CH2, or ADD operation

When in the DUAL or ADD mode of operation, the signal of the channel selected by the SOURCE switch (26) is used for triggering.



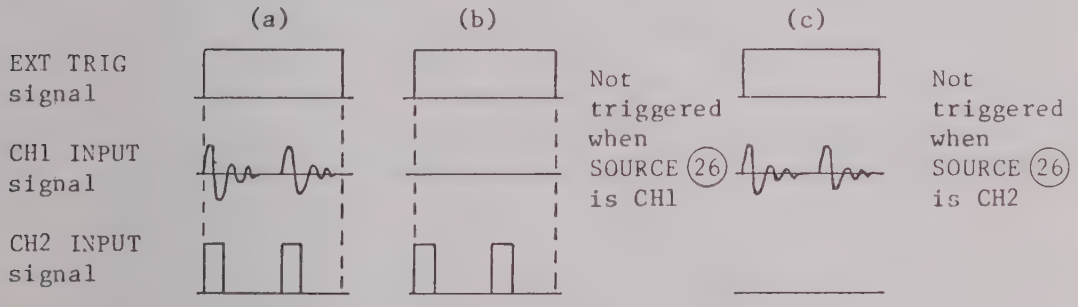
Trigger source signal when in DUAL or ADD operation

Note: Refer to 2 "Dual-channel operation" on page 35.

LINE: The AC line frequency signal is used for triggering. This triggering is effective when the measured signal has a time relationship with the AC line frequency, expecially for measurement of low level noise of audio equipment, etc.

o External Trigger

EXT: The sweep is triggered with an external signal applied to the external trigger input terminal (23). An external signal which has a periodic relationship with respect to the measured signal is used. Since the measured signal is not used as the triggering signal, waveform can be displayed more independently of the measured signal.



When CH1 and CH2 input signals vary:

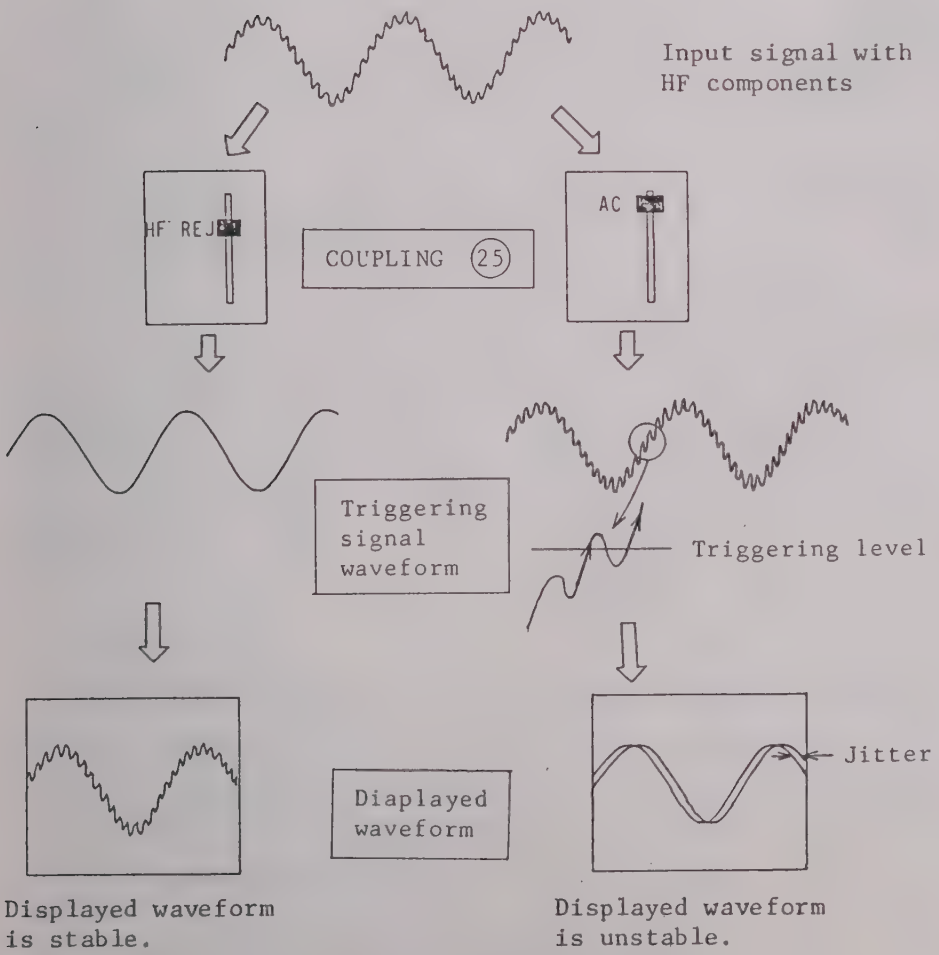
In the case of (a), triggering is effected with the SOURCE switch (26) set to CH1 or CH2. In the case of (b) or (c), no triggering is effected with the SOURCE switch (26) set to CH1 or CH2 and, therefore, an external trigger signal should be used.

2) Functions of COUPLING Switch (25)

This switch selects the AC, HF REJ, TV, or DC coupling mode for the triggering signal fed to the trigger circuit.

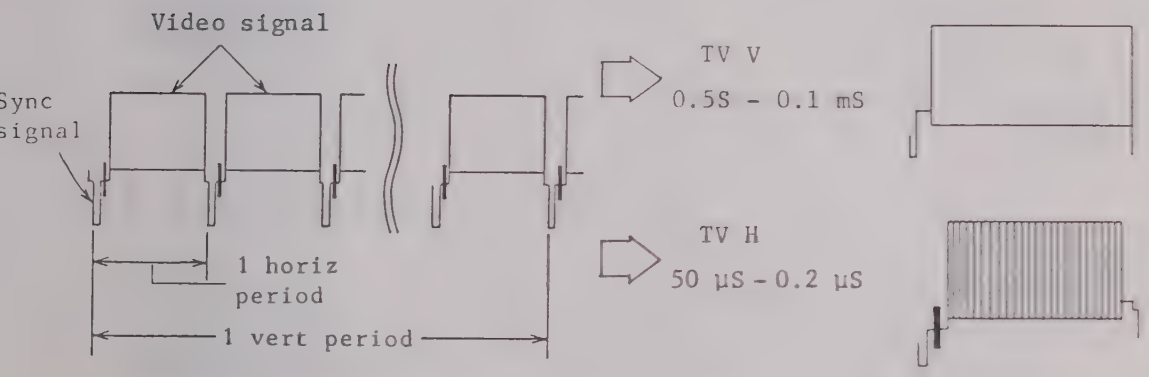
AC: The DC and very low frequency components (lower than 10 Hz) of the triggering signal are cut off, thereby making triggering operation stable. This coupling mode is used most commonly.

HF REJ: The higher frequency components of the triggering signal are cut off. The triggering signal is fed to the trigger circuit via an AC-coupling circuit and a low-pass filter (50 kHz, -3 dB).

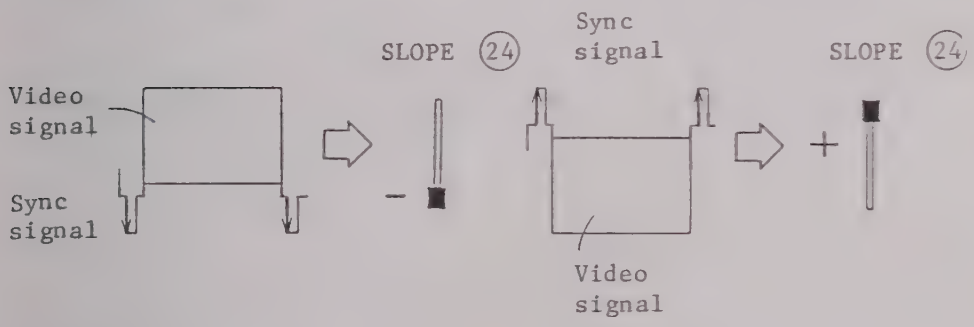


TV: This coupling is used for TV triggering for observation of TV video signals. The triggering signal is AC-coupled and fed via the trigger circuit (level circuit) to the TV sync separator circuit. The separator circuit picks off the sync signal, which is used to trigger the sweep. Thus, the video signal can be displayed very stably.

Being linked to the TIME/DIV switch, the sweep speed is switched for TV.V and TV.H as follows:



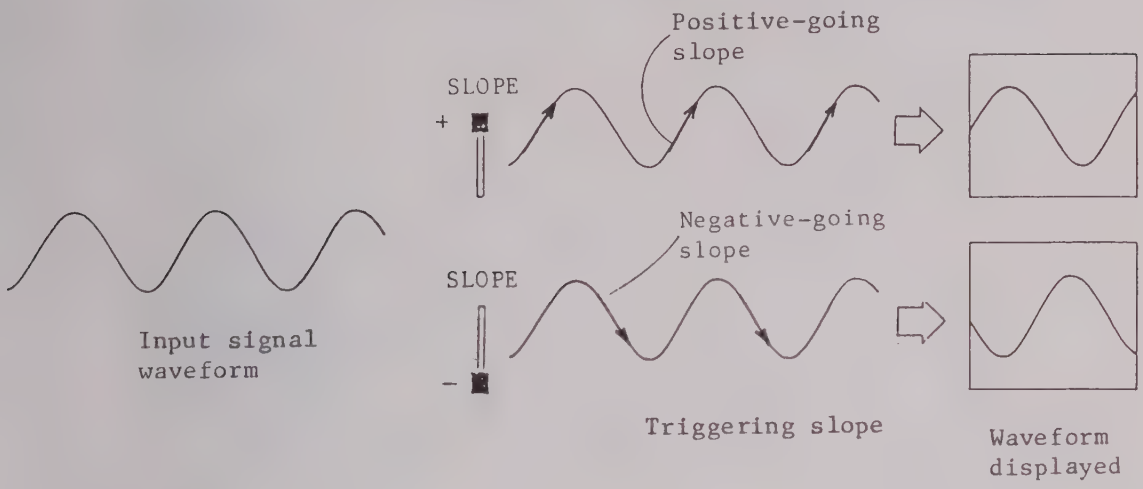
The SLOPE switch (24) should be set in conformity with the video signal as follows:



DC: The triggering signal is DC-coupled to the trigger circuit. This mode is used when triggering by the DC component of the triggering signal is desired or when a very low frequency signal or a signal of large duty cycle ratio is needed to be displayed.

3) Functions of SLOPE Switch (24) :

This switch selects a slope (polarity) for triggering.



4) Functions of LEVEL (LOCK) control (22) :

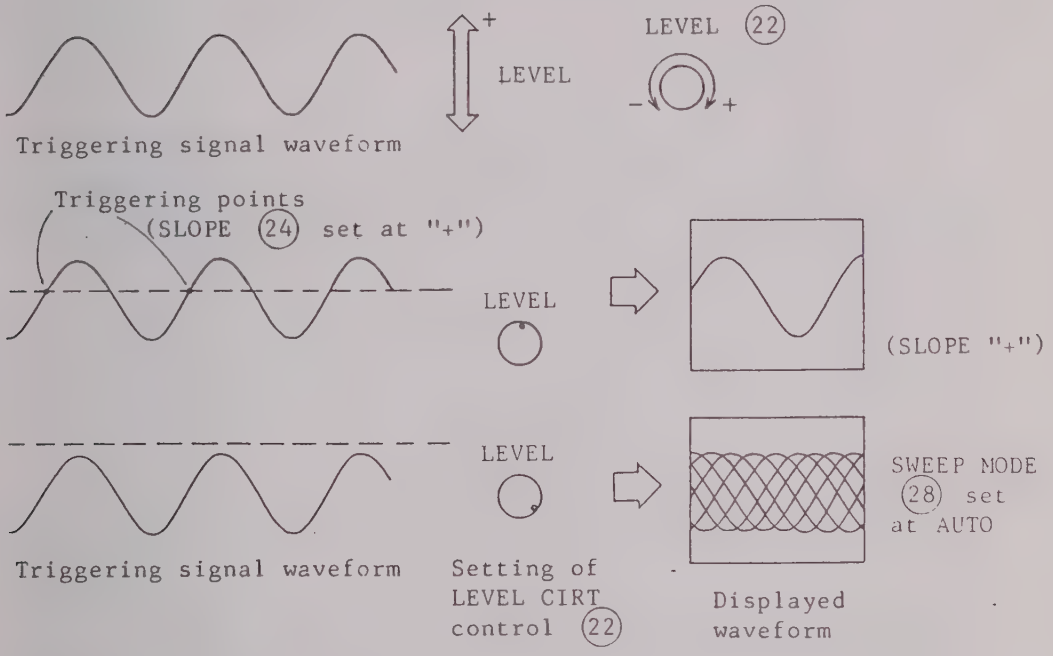
This control is used to adjust the triggering level for stable display of waveforms. When this control is set in the LOCK position (counterclockwise extreme position), stable triggering is automatically realized within the following ranges (for signals of duty cycle not greater than 80:20):

50 Hz - 10 MHz: 1.0 DIV or less (0.15 V or less when in EXT mode)

50 Hz - 20 MHz: 2.0 DIV or less (0.25 V or less when in EXT mode)

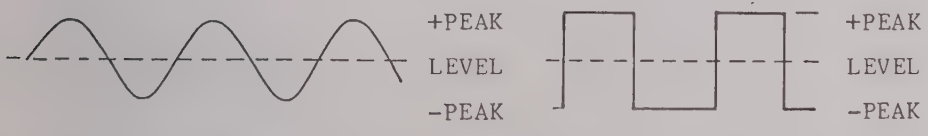
o Triggering Level

The sweep circuit is triggered when the triggering signal has crossed the triggering level, to display a stationary waveform on the CRT.



o Level Lock Function

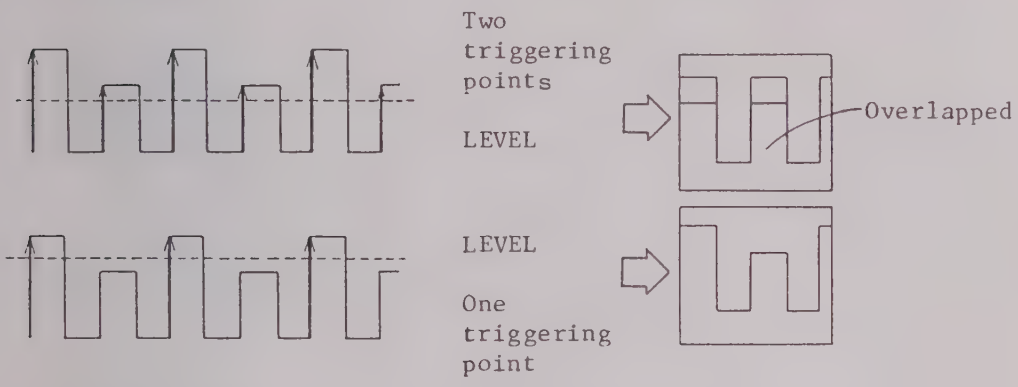
When the LEVEL control (22) is set at the LOCK position, the triggering level is automatically set at a center between peaks of the input signal waveform and no manual level adjustment is needed.



Triggering Input Signal and Triggering Level
When in LEVEL LOCK Mode

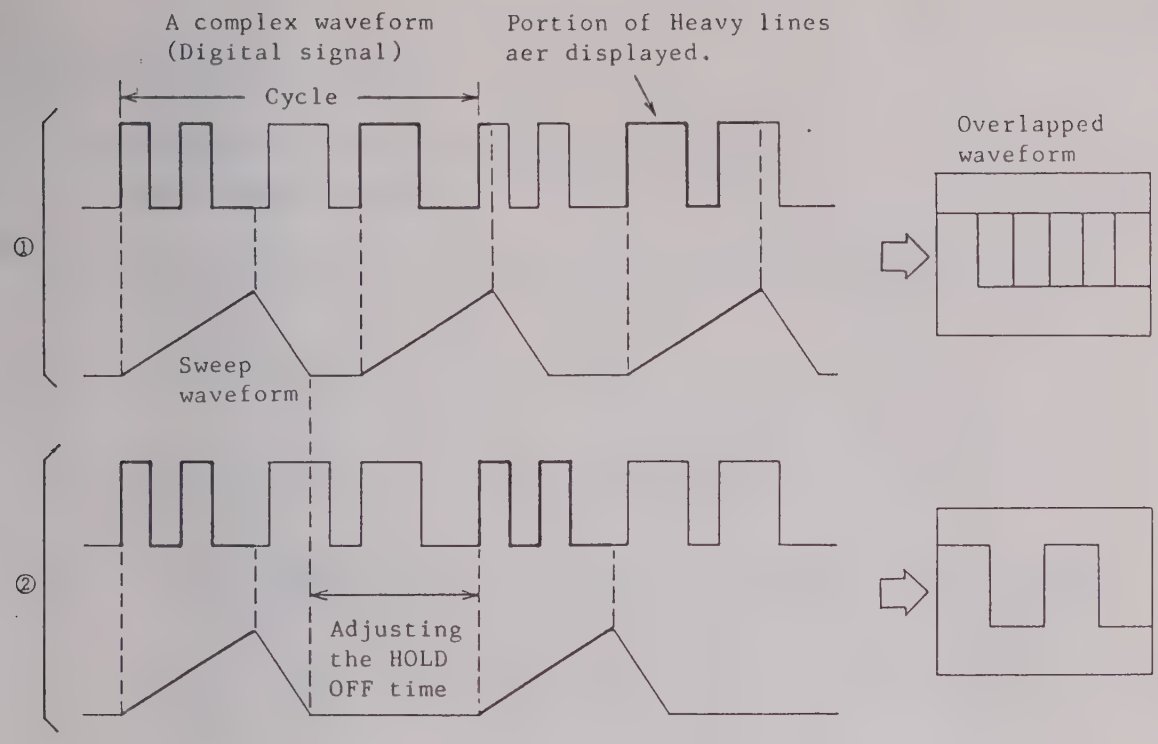
o Level Adjustment of Complicated Waveforms

When the signal waveform is complicated as shown in the below example, two or more triggering points may result and the displayed waveform may be with two or more patterns overlapped. If such is the case, adjust the LEVEL control (22) so that only one triggering point is selected.



5) Functions of HOLD OFF control (21) :

When the measured signal has a complex waveform with two or more repetition frequencies (periods), triggering with the LEVEL control (22) alone may not be sufficient for attaining a stable waveform display. In such a case, the sweep can be stably synchronized to the measured signal waveform by adjusting the HOLD OFF time (sweep pause time) of the sweep waveform by means of the HOLD OFF control (21) .



① shows a case for HOLD OFF knob at the NORM position. Various different waveforms are overlapped on the CRT screen, making the signal observation unsuccessful.

② shows a case in which the undesirable portion of the signal is held off. The waveform is displayed on the CRT screen without overlapping.

6 Single-sweep Operation

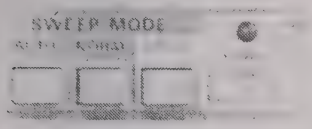
The single-sweep operation is effective for measurement of the following types of signals:

- o A signal whose amplitude or period varies at random and cannot be displayed as a stationary waveform.
- o A signal of one-shot event

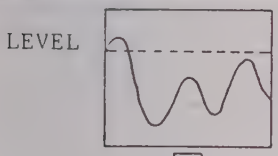
The single-sweep waveform may be photographed for viewing and analysis.

Note: Note, when taking photographs of the waveforms, that CH1 and CH2 are alternately swept if the oscilloscope is operating in the dual-channel single-sweep mode and the TIME/DIV switch (30) is set at 0.5 msec or slower.

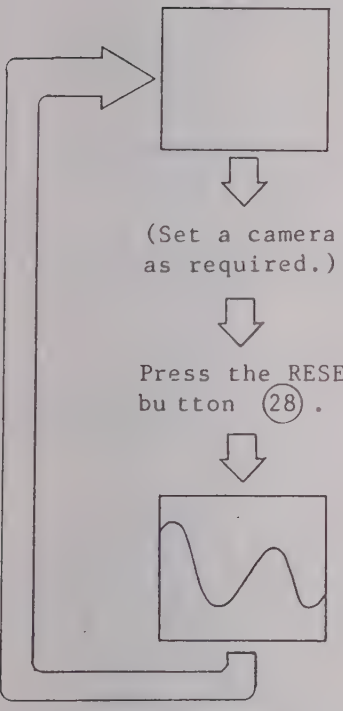
o Measurement of Non-repetitive Signal



1) Set the SWEEP MODE switch (28) to the NORM position.



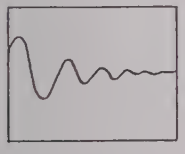
2) Apply the signal to be measured to the vertical input terminal 11 or (18). Adjust the triggering level with the LEVEL control (22).



3) Set the SWEEP MODE selector (28) in the SINGLE state (all of the three buttons are pushed out). The CRT screen will be blanked out.

4) Each time as you press the RESET button (28) (which is used also as the SINGLE button), the sweep runs only once and a waveform without overlapping is displayed and then the oscilloscope is reset to the state of 3).

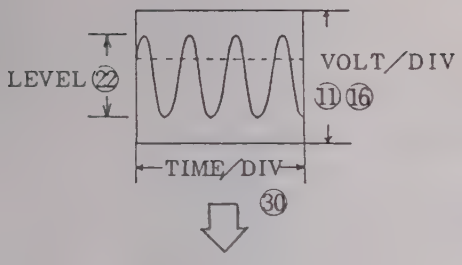
o Measurement of One-shot Signal

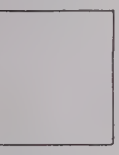


Anticipated one-shot signal

1) If the amplitude and period of the signal to be measured are predictable, set the oscilloscope accordingly.

2) Set the SWEEP MODE selector (28) to the NORM state.

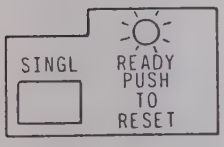




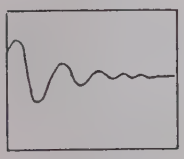
Set a camera as required.

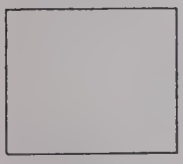
Connect a signal to be measured.

Press the RESET button.



READY lamp turns on.





○ READY lamp goes off.

3) Apply a signal which is similar

vertical input terminal 11 or 18 , and set accordingly the VOLTS/DIV switch (12) or (16) , TIME/DIV switch (30) and LEVEL control (22) .

4) Set the SWEEP MODE selector (28) to the SINGLE state (all of the three buttons are pushed out).

5) Connect the measured signal to the vertical input terminal (11) or (18) , using the probe or other means.

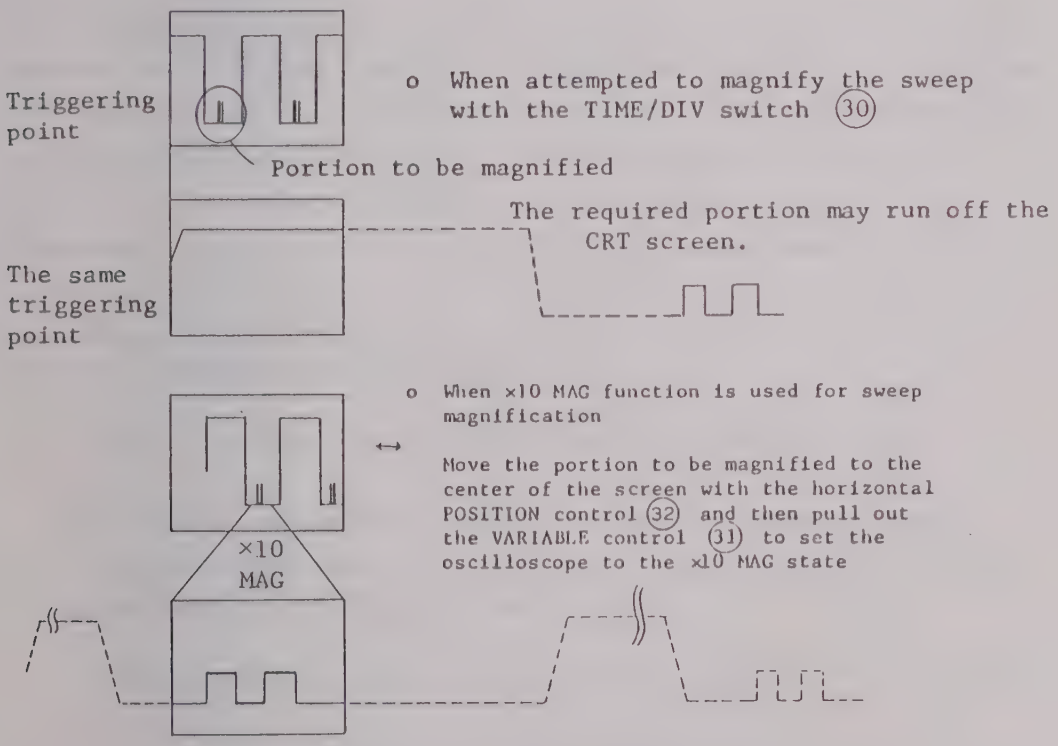
6) Press the RESET button (28) (which is used also as the SINGLE button) so that the sweep circuit becomes the ready state and the READY lamp (27) turns on.

7) As the signal to be measured is applied (as the phenomenon to be analyzed takes place), the sweep runs only once and then the READY lamp (27) goes off.

8) To repeat the viewing, repeat from step 6).

7 Sweep Magnification

When a certain position of the displayed waveform is needed to be expanded timewise, a faster sweep speed may be used. However, if the required portion is far away from the starting point of the sweep, the required portion may run off the CRT screen. In such a case, pull out (set in the ×10 MAG state) the sweep VARIABLE knob (31). When this is done, the displayed waveform is expanded by 10 times to right or left with the center of screen as the center of expansion.


Triggering point
Portion to be magnified
The same triggering point
The required portion may run off the CRT screen.
×10 MAG

o When attempted to magnify the sweep with the TIME/DIV switch (30)

o When ×10 MAG function is used for sweep magnification

Move the portion to be magnified to the center of the screen with the horizontal POSITION control (32) and then pull out the VARIABLE control (31) to set the oscilloscope to the ×10 MAG state

↔ Any portion of the waveform can be covered by means of the horizontal POSITION control.

The sweep time during the magnification operation is obtained as follows:

(Value indicated by TIME/DIV switch) × 1/10

Thus, the unmagnified maximum sweep speed (0.2 μsec/DIV) can be made faster with magnification as follows:

0.2 μsec/DIV × 1/10 = 20 nsec/DIV

6.2 Measurement in Storage Mode

This chapter discribes the operation methods of the DSS5020 as a digital storage oscilloscope, comparing its performances with those of storage-CRT oscilloscopes as cases may call for. The basic operation methods of the DSS5020 are identical for both storage use and non-storage use. Before operating the oscilloscope in the storage mode, make yourself thoroughly familiar with its operation in the non-storage mode referring to the preceding chapter.

Notes for Operation in the Storage Mode

1) Items to be noted when switched over to the storage mode:

Note that no signal data can be acquired and measured in the below-mentioned cases. In such cases, observe the instructions given there for individual cases.

- o The SAVE switch (29) is in the ON (⌐¬) state:

  Set it to the OFF (⌐⌐) state.

- o The SWEEP MODE selector (28) is set in the NORM state and no triggering is effected:

  Turn the LEVEL control (22) to the LOCK position (counter-clockwise extreme position) or adjust it so that triggering is effected. If triggering cannot be successfully effected, check the amplitude and other factors of the signal by setting the SWEEP MODE selector (28) to the AUTO state.

o None of the modes are selected by the SWEEP MODE selector (28) :

Select the AUTO or NORM mode with the SWEEP MODE selector (28) .

The above are applicable also when the POWER switch (3) is turned on with the oscilloscope set in the storage mode.

2) Items to be noted when in operation:

o If a waveform which has been saved with the TIME/DIV switch (30) set at a range lower than 0.1 msec is displayed with the TIME/DIV switch (30) set at a range slower than that with which the waveform has been saved, the displayed waveform blinks to indicate that the displayed waveform is invalid. A similar alarm indication occurs also when a waveform which has been saved with a range higher than 50 µsec is displayed with the TIME/DIV switch (30) set at a range lower than 0.1 msec.

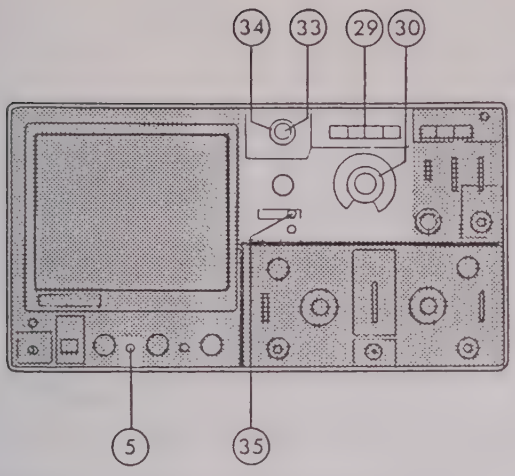
o When in the storage mode, the time base VARIABLE control (31) , HOLD OFF control (21) , and the X-Y function remain idle.

o No waveform backup is done when operation is changed from the storage mode to the non-storage mode or when the POWER switch (3) is turned off.

1 Waveform Measurement in Storage Mode

1) To measure waveforms in the storage mode, set at first the switches and controls as follows:

Switch or Control		Setting
STORAGE MODE (29)		
STORE/NON-STORE	⊓	NON-STORE
SINE/PULSE	⊓	PULSE interpolation
SAVE	⊓	OFF
REF	⊓	OFF
TRIG POSITION (34)	↺	2-DIV position
STORE INTERVAL (33)	↺	MIN (counterclockwise)



2) In the non-storage mode, display the waveform to be measured.

3) Change the STORE/NON-STORE switch (29) to the STORE (⊓) state. The waveform will be digitally stored and displayed continuously.

Of the DSS5020, operation is automatically changed to the interpolation mode when the sweep speed is 50 μsec or faster and automatically changed to the roll mode when the sweep speed is slower than 0.1 sec. Data acquisition speed also is automatically changed by the TIME/DIV switch (30).

☆ Interpolation

Interpolation is a function of estimating a value between two measured data values of a waveform. The DSS5020 is able to render pulse interpolation and sine interpolation.

o Pulse Interpolation

Pulse interpolation is referred to also as linear interpolation since a value between two known values is estimated employing a linear function. By magnifying the waveform with this interpolation, perceptual aliasing can be prevented. This interpolation facilitates measurement of waveform which is located apart by one sample point.

When a sine wave signal is measured and the number of sample points per one input signal cycle is less than 10, envelope errors as shown in Figure 6-2 are introduced. In such a case, sine interpolation should be used.

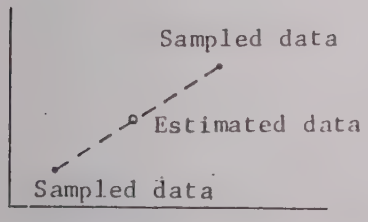


Figure 6-1. Pulse Interpolation

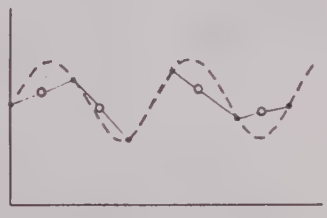


Figure 6-2. Envelope Errors of Pulse Interpolation

o Sine Interpolation

Sine interpolation is effectively applicable to most of the waveforms so far as their frequency spectrum is higher than 1/2.5 of the sampling frequency. The DSS5020, whose maximum sampling frequency is 1 MHz, is able to render effective sine interpolation up to the following frequency for a sine wave which has a single spectrum only.

1 MHz × 1/2.5 = 400 kHz

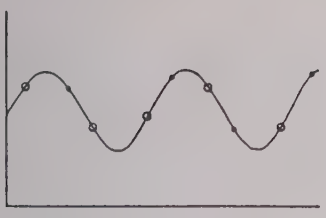


Figure 6-3. Sine Interpolation

o To Select Type of Interpolation

Either pulse interpolation or sine interpolation should be selected depending on whether the input signal waveform involves frequencies higher than 1/2.5 of the sampling frequency or not. If a square wave, which involves much harmonics, is sine-interpolated, overshoots and preshoots may result. If a sine wave is pulse-interpolated on the other hand, envelope errors as shown in Figure 6-2 may result. Therefore, use sine interpolation for sinusoidal waves and pulse interpolation for waves distorted with harmonics.

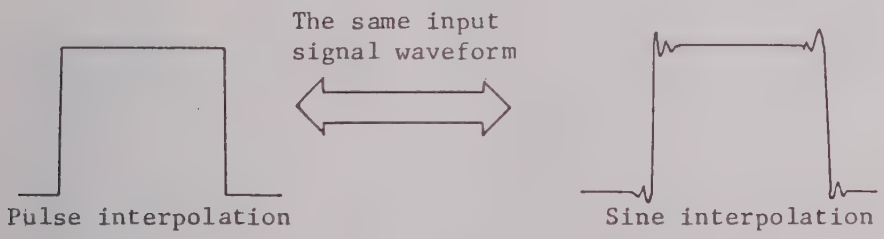


Figure 6-4

Note, however, that the interpolated values are no more than estimated values. They do not represent any actually measured data values. When measuring a signal waveform, therefore, it is most recommendable to compare it with the waveform displayed in the non-storage mode. This comparison can be rapidly accomplished simply by changing the STORE/NON-STORE switch (29).

☆ Roll Mode

When in the regular mode (50 msec/DIV or over), the displayed waveform is not updated until storing of data is over. If a waveform is displayed at a very low speed when in the above condition, the waveform will take a long time before it is updated

and this will be inconvenient for waveform viewing. To solve this problem, the DSS5020 employs such system that, when the TIME/DIV switch (30) is set at a range lower than 0.1 sec/DIV, the waveform is displayed in a roll mode and sequentially updated as data is stored and, when the sweep is triggered, the stored data is re-arranged so that the triggered point conforms with the position selected by the TRIG POINT control (34).

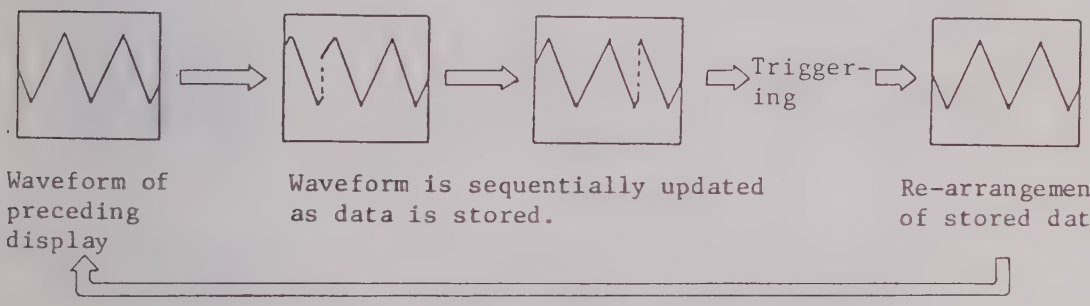


Figure 6-5. ROLL Mode

Note: If the SWEEP MODE selector (28) is set in the AUTO or NORM state, storing of waveform data resumes immediately after triggering of sweep and re-arrangement of stored data is over. For more convenient viewing, the displayed waveform can be held for a certain adjustable period of time (approximately 0.5 to 5 seconds) before starting storing of data for the next display.

2	To Save Waveform

1) In the STORE mode, display the waveform to be saved.

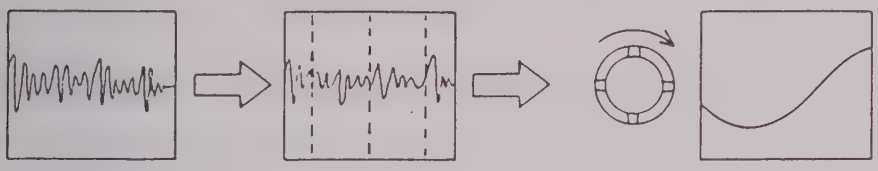
2) Press the SAVE switch (29). The waveform displayed at that instant will be saved, storing of data will cease, and the SAVE lamp (36) will illuminate.

3	To Magnify the Saved Waveform

1) Save the waveform to be magnified.

2) Select a center of magnification with the TRIG POINT control (34).

3) The displayed waveform can be magnified up to 100 times by setting the TIME/DIV switch (30) at a range faster than that with which the waveform has been saved. The set range of the TIME/DIV switch (30) directly is the time base for the magnified waveform display.



Save waveform with SAVE (29).

Select center of magnification with TRIG POINT (34).

Expand time base with TIME/DIV (30).

Note: If the display time base is slower than the save time base or if it is faster than 100 times of the save time base (except the case of 0.1 msec/DIV), the displayed waveform blinks to indicate that it is invalid.

4	To Compare Waveforms

1) Display a reference waveform and save it by pressing the REF switch (29).

2) Display a waveform to be compared. Align the two waveforms for comparison by using the vertical POSITION controls (9) and (20).

Save the reference waveform. (REF (29))

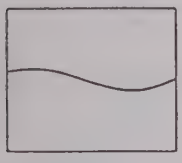
Display two waveforms overlappingly. (POSITION (9) (20))

o To update the reference waveform, press the REF switch once for resetting and then press it once more for saving.

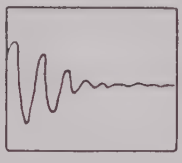
5 To Save Waveform in Single-sweep Mode

1) Set the switches and controls as in the case of the non-storage mode of 6.1 (6). While the oscilloscope is waiting for triggering as in the case of the non-storage mode, data is continuously stored and the displayed waveform is continuously updated if the oscilloscope is set in the ROLL mode.

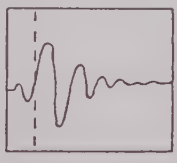
2) When triggering is effected, waveform data is re-arranged so that the triggered point conforms with that selected by the TRIG POINT control (34), and the re-arranged waveform is displayed and saved automatically.



Ready for triggering, with preceding waveform displayed. (RESET (28))



Triggering for single-sweep display. (Display only in ROLL mode)



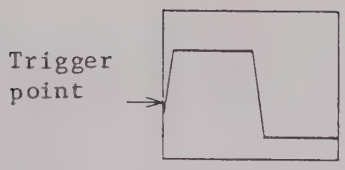
Waveform displayed and saved, being re-arranged for pre-selected triggering point.

o The waveform saved in the single-sweep mode can be magnified as in the case of the regular save operation.

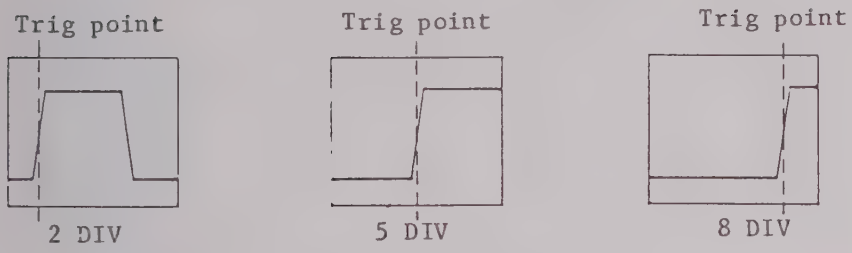
6 To View Waveform Existed Before Triggering

With conventional oscilloscopes (including storage-CRT oscilloscopes), waveform which existed before the triggering cannot be displayed because the sweep starts after triggering is effected. Although delay lines may be used to view the pre-triggering waveforms, up to several hundreds nanoseconds is the maximum with such provisions.

With the DSS5020, on the other hand, pre-triggering waveform can be observed for 2, 5, or 8 DIV of the graticule. This is realized as the DSS5020 constantly stores the input signal and the end point of storing is distated by the triggering signal. The range of the pre-triggering portion of the displayed waveform is selectable for 2, 5, or 8 DIV with the TRIG POSITION control (34).

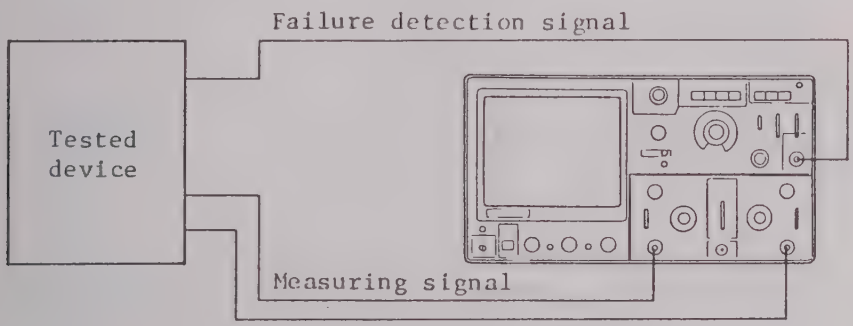


Conventional oscilloscope



DSS5020 Digital Storage Oscilloscope

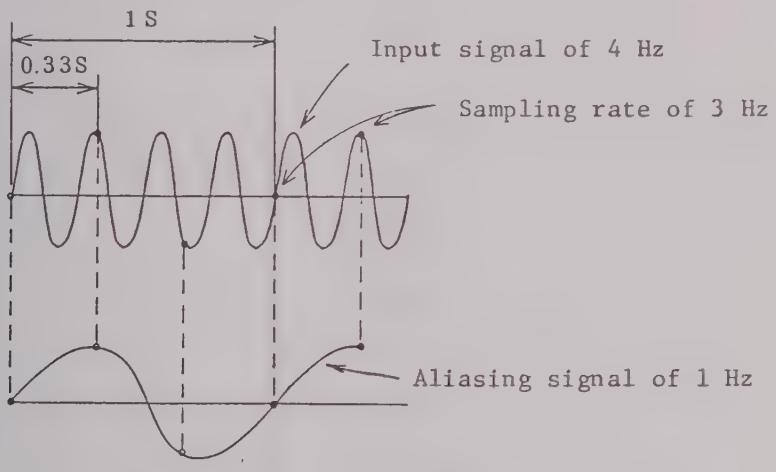
An example of setup for analysis of failures which occur at unpredictable instances, making use of the pre-triggering waveform display function together with the external triggering function and single-sweep function, is illustrated below.



With the above setup and the oscilloscope set in the READY state for single-sweep, when the device failure detection signal is applied as a triggering signal, the oscilloscope automatically saves the measuring signal which existed immediately before the triggering. Thus, the required data even for a failure of which the time of occurrence is unpredictable can be successfully saved and the operator is relieved from constantly watching the CRT screen for an event of which occurrence time is unpredictable or which may not occur at all.

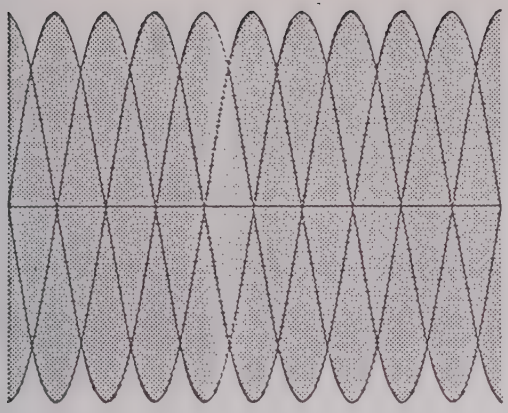
☆ Aliasing

One of the errors introduced when operating an oscilloscope at a range above its performance is aliasing. Aliasing is such phenomenon that, when the input signal frequency has become higher than a half of the sampling frequency, the input signal cannot be reproduced theoretically and the oscilloscope displays a waveform whose frequency differs from that of the input signal. For example, if an input signal of 4 Hz is digitized with a sampling rate of 3 Hz, a waveform of 1 Hz is displayed. One of the most effective means of identifying aliasing is to change operation of the oscilloscope to the non-storage mode and check whether the frequency of the displayed waveform is definitely different from that of the input signal or not.



The sampling rate differs by the TIME/DIV range. Consequently, the frequency at which aliasing occurs differs by the TIME/DIV range.

There is another type of aliasing, namely, perceptual aliasing. This aliasing occurs even when the input signal frequency is lower than a half of the sampling frequency. As the input signal frequency becomes closer to a half of the sampling frequency, the nearest sampling point is erroneously taken for the next sampling point, thereby causing perceptual aliasing. Thus, perceptual aliasing differs from the true aliasing. Perceptual aliasing can be eliminated by magnifying the waveform by means of interpolation.



The frequency ranges within which the correct waveform measurement can be done without aliasing are shown in the following table. The values shown in the table may be effectively utilized in such cases that waveforms are displayed in the one-sweep mode.

TIME/DIV (30)	Frequency (Hz)	TIME/DIV (30)	Frequency (Hz)
1 sec	DC - 50	5 msec	DC - 10k
0.5 sec	DC - 100	2 msec	DC - 25k
0.2 sec	DC - 250	1 msec	DC - 50k
0.1 sec	DC - 500	0.5 msec	DC - 100k
50 msec	DC - 1k	0.2 msec	DC - 250k
20 msec	DC - 2.5k	0.1 msec	DC - 500k
10 msec	DC - 5k	Up to 0.5 μsec	DC - 500k

7. OPERATING PRINCIPLE

7.1 Basic Principle of Digital Storage Oscilloscope

7.1.1 Digital Storage Oscilloscope

The term "storage oscilloscope" in the past was applied to an oscilloscope which employed a storage CRT. This type of oscilloscope stores the displayed waveform by the function of the cathode-ray tube itself.

Recently, digital storage oscilloscopes have become available. The basic principle of this type of oscilloscope is as shown in Figure 7-1.

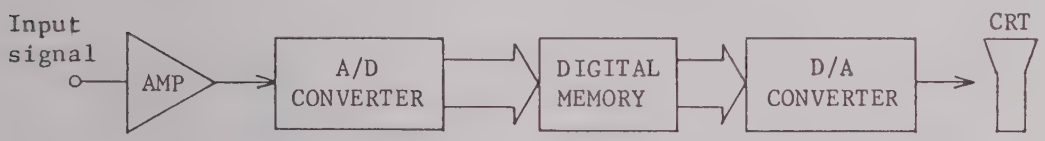


Figure 7-1. Basic Principle of Digital Storage Oscilloscope

As shown in Figure 7-1, the analog input signal is converted into a digital signal data and stored in a digital memory. To reproduce the waveform on the CRT, the data stored in the memory is sequentially read and converted into an analog signal in order to be displayed on the CRT. By reading the data at a frequency higher than causing flicker (at a frequency of 50 Hz or over), the read data can be displayed as a flickerless stationary waveform on the CRT screen.

7.1.2 A/D Converter

The A/D converter converts the analog input signal into a digital signal in order to be stored in the digital memory. The amplitude of the analog signal continuously vary by time. For conversion into a digital signal, the analog signal should be sampled at certain intervals. Each of the sampled analog signal is quantitized into a digital signal. See Figure 7-2.

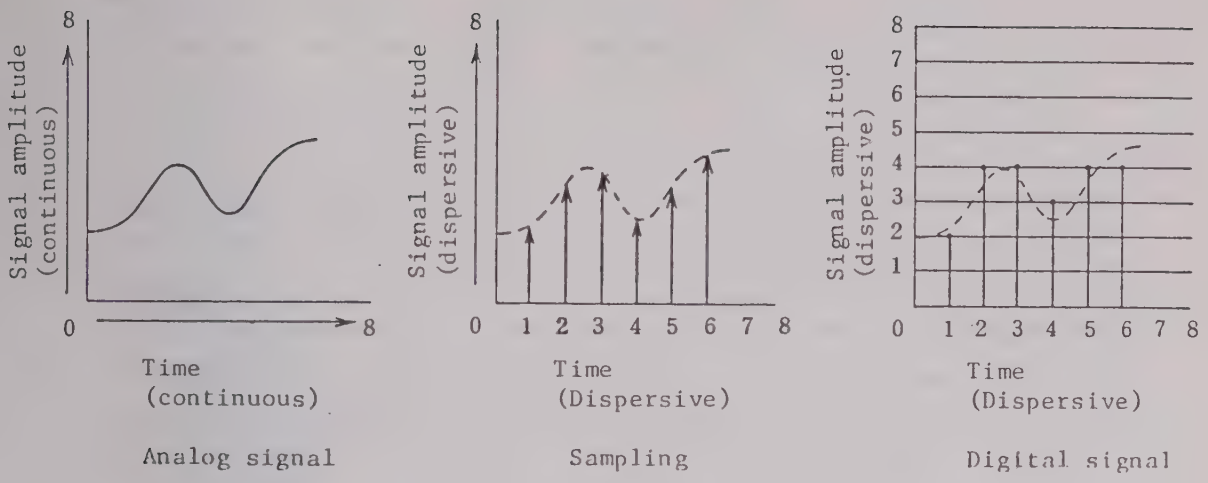


Figure 7-2. A/D Converter

7.1.3 Digital Memory

The analog signal quantitized into a digital signal by the A/D converter is stored in the digital memory. The digital quantities of the signal shown in Figure 7-2 for example are as shown in Table 7-1. These quantities as data values are stored at respective addresses of the digital memory.

Table 7-1. Time and Data

Time	1	2	3	4	5	6
Data	2	4	4	3	4	4

7.1.4 D/A Converter

In order to be displayed as an analog signal, the digital data stored in the digital memory is converted back into analog values by the D/A converter. The function of the D/A converter is in the reverse of that of the A/D converter.

7.2 Circuit Structure

The circuit structure of the DSS5020 is as shown in the block diagram of Figure 7-3. The major blocks are the vertical deflection circuit, horizontal deflection circuit, data acquisition and processing circuit,

CRT circuit, CAL circuit and power supply circuit. Individual circuits are described in the subsequent paragraphs.

7.2.1 Vertical Deflection Circuit

The vertical deflection circuit is for vertically deflecting the beam spot on the CRT screen. The input signal is impedance-converted and amplified by the CH1 or CH2 preamplifier to a level suitable for driving the subsequent stage of the circuit. The channel selector selects the channel to be used, being controlled by the CPU. Then the signal is fed to the STORE SIGNAL PICKOFF circuit. The signal picked off is fed to the A/D converter. The vertical mode selector selects either the storage signal or non-storage signal. The selected signal is fed to the vertical output amplifier which amplifies the signal to a sufficient level for vertically deflecting the CRT beam.

7.2.2 Horizontal Deflection Circuit

The horizontal deflection circuit is for horizontally deflecting the beam spot on the CRT screen. It has a trigger circuit and a sweep circuit. It operates also as an X-axis deflection circuit for X-Y operation.

The trigger generator selects either the signal fed from the channel selector or the EXT TRIG signal, and generates a triggering signal for sweep and an AUTO signal to indicate existence/absence of the triggering signal.

When in the X-Y mode or EXT HOR mode, the circuit operates as an X-axis amplifier.

The non-storage mode sweep generator generates a sweep signal for operation in the non-storage mode, being synchronized with the triggering signal.

The horizontal mode selector selects the storage mode sweep signal, the non-storage mode sweep signal, or the X-axis signal. The selected signal is amplified by the horizontal output amplifier to a sufficient level for horizontally driving the CRT beam.

7.2.3 Data Acquisition & Processing Circuit

This circuit converts the analog input signal into a digital signal for storage and renders interpolation on the stored data for reproduction of the analog signal on the CRT screen. The various data items fed through the I/O port are read by the CPU which provides the control signals for the various circuits. The waveform data fed from the A/D converter is stored in the main memory. The CPU provides interpolation and other processings on the data. The processed data is transferred to the display memory. Except during the transfer periods, the contents of the display memory are constantly sent to the D/A converter and displayed on the CRT.

7.2.4 CRT Circuit

The CRT circuit provides the high voltages for the CRT and controls the Z-axis of the CRT. The Z-axis amplifier amplifies the Z-axis signal to a sufficient level for controlling the brightness of the CRT beam spot. The HV regulator provides a high voltage for the CRT. The voltage is controlled by the CRT control circuit via the Z-axis output amplifier, to control the CRT beam spot intensity and focus.

7.2.5 CAL Circuit and Power Supply Circuit

The CAL circuit provides a reference signal for calibration of the probe and for operation of the amplifiers in the non-calibrated state. The reference signal is a square wave of 2 Vp-p, with voltage accuracy better than 2%.

The power supply circuit provides supply voltages (115V, 12V, -12V, and 5V) for the various circuits of the oscilloscope.

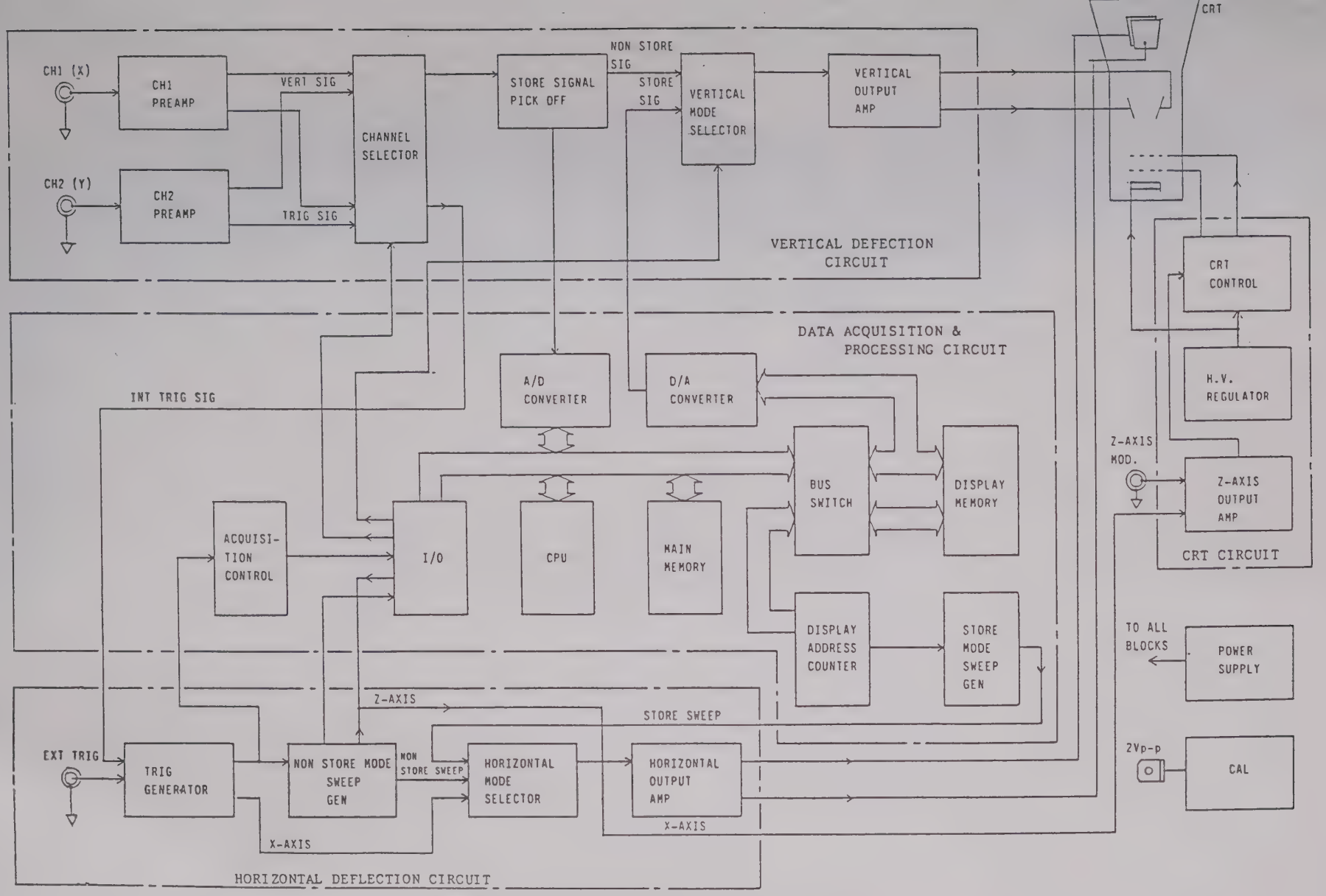


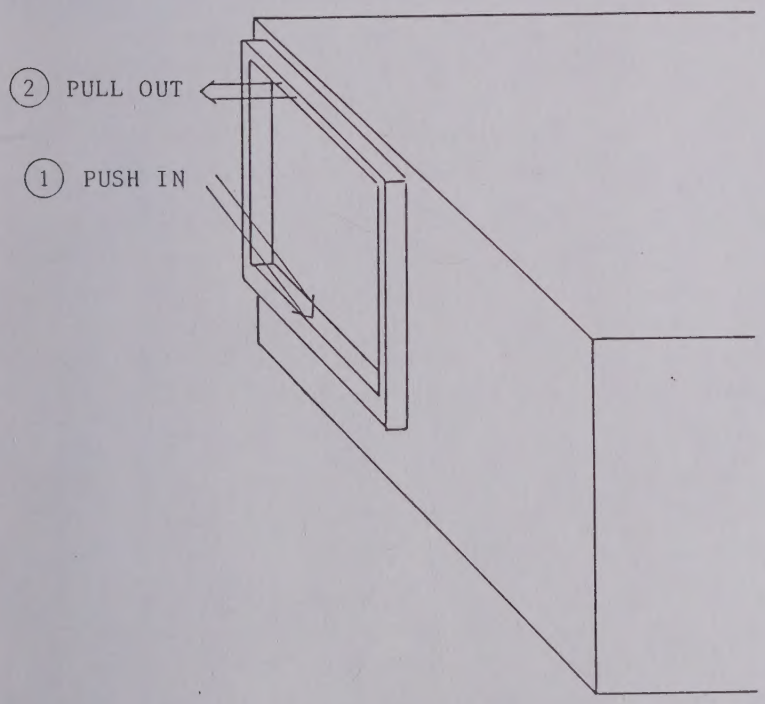
Figure 7-3. Block Diagram of DSS5020

8. MAINTENANCE AND STORING

The DSS5020 employs precision components and high voltage parts. Exercise care when transporting or storing it.

To clean the filter and front face of CRT:

To clean the filter and the front face of CRT, remove the filter as illustrated below and clean them using a soft cloth.



WARRANTY

All instruments manufactured by KIKUSUI ELECTRONICS CORP. are warranted against defects in materials and workmanship for a period of two years from the date of original shipment from the factory. However, this warranty excludes batteries, lead wires and probes, and CRT's are warranted only for a period of one year from the date of original shipment from the factory.

In the event of any defects in materials or workmanship, KIKUSUI ELECTRONICS CORP. will, at its sole option, repair or replace the defective instrument covered by this warranty without charge. To obtain warranty service, the defective instrument must be returned within thirty (30) days of the expiration of the applicable warranty period to KIKUSUI INTERNATIONAL CORP. properly packaged and with transportation and insurance prepaid. We will reship at our expense only to destinations in the United States.

Any defect in materials or workmanship determined by KIKUSUI INTERNATIONAL CORP. to be attributable to customer alteration, modification, negligence or misuse is not covered by this warranty.

EXCEPT AS SET FORTH ABOVE, KIKUSUI ELECTRONICS CORP. AND KIKUSUI INTERNATIONAL CORP. MAKE NO WARRANTIES EITHER EXPRESS OR IMPLIED, WITH RESPECT TO SUCH INSTRUMENTS, AND SHALL NOT BE LIABLE OR RESPONSIBLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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